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THE UNITED STATES  
STRATEGIC BOMBING SURVEY

EFFECTS OF  
THE ATOMIC BOMB  
ON  
NAGASAKI, JAPAN


Volume I

COPY

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Physical Damage Division

June 1947

  
THE UNITED STATES  
STRATEGIC BOMBING SURVEY

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ON  
NAGASAKI, JAPAN


Volume I

Physical Damage Division

Dates of Survey:

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This report was written primarily for the use of the United States Strategic Bombing Survey in the preparation of further reports of a more comprehensive nature. Any conclusions or opinions expressed in this report must be considered as limited to the specific material covered and as subject to further interpretation in the light of further studies conducted by the Survey.

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## FOREWORD

The United States Strategic Bombing Survey was established by the Secretary of War on 3 November 1944, pursuant to a directive from the late President Roosevelt. Its mission was to conduct an impartial and expert study of the effects of our aerial attack on Germany, to be used in connection with air attacks on Japan and to establish a basis for evaluating the importance and potentialities of air power as an instrument of military strategy for planning the future development of the United States armed forces and for determining future economic policies with respect to the national defense. A summary report and some 200 supporting reports containing the findings of the survey in Germany have been published.

On 15 August 1945, President Truman requested that the Survey conduct a similar study of the effects of all types of air attack in the war against Japan, submitting reports in duplicate to the Secretary of War and to the Secretary of the Navy. The officers of the Survey during its Japanese phase were:

Franklin D'Olier, *Chairman*.

Paul H. Nitze, Henry C. Alexander, *Vice Chairmen*.

Harry L. Bowman,

J. Kenneth Galbraith,

Rensis Likert,

Frank A. McNamee, Jr.,

Fred Searls, Jr.,

Monroe E. Spaght,

Dr. Lewis R. Thompson,

Theodore P. Wright, *Directors*.

Walter Wilds, *Secretary*.

The Survey's complement provided for 300

civilians, 350 officers, and 500 enlisted men. The military segment of the organization was drawn from the Army to the extent of 60 percent, and from the Navy to the extent of 40 percent. Both the Army and the Navy gave the Survey all possible assistance in furnishing men, supplies, transport, and information. The Survey operated from headquarters established in Tokyo early in September 1945, with subheadquarters in Nagoya, Osaka, Hiroshima, and Nagasaki, and with mobile teams operating in other parts of Japan, the islands of the Pacific, and the Asiatic mainland.

It was possible to reconstruct much of wartime Japanese military planning and execution, engagement by engagement, and campaign by campaign, and to secure reasonably accurate statistics on Japan's economy and war production, plant by plant, and industry by industry. In addition, studies were conducted on Japan's over-all strategic plans and the background of her entry into the war, the internal discussions and negotiations leading to her acceptance of unconditional surrender, the course of health and morale among the civilian population, the effectiveness of the Japanese civilian defense organization, and the effects of the atomic bombs. Separate reports will be issued covering each phase of the study.

The Survey interrogated more than 700 Japanese military, government, and industrial officials. It also recovered and translated many documents which not only have been useful to the Survey, but also will furnish data valuable for other studies. Arrangements have been made to turn over the Survey's files to the Central Intelligence Group, through which they will be available for further examination and distribution.

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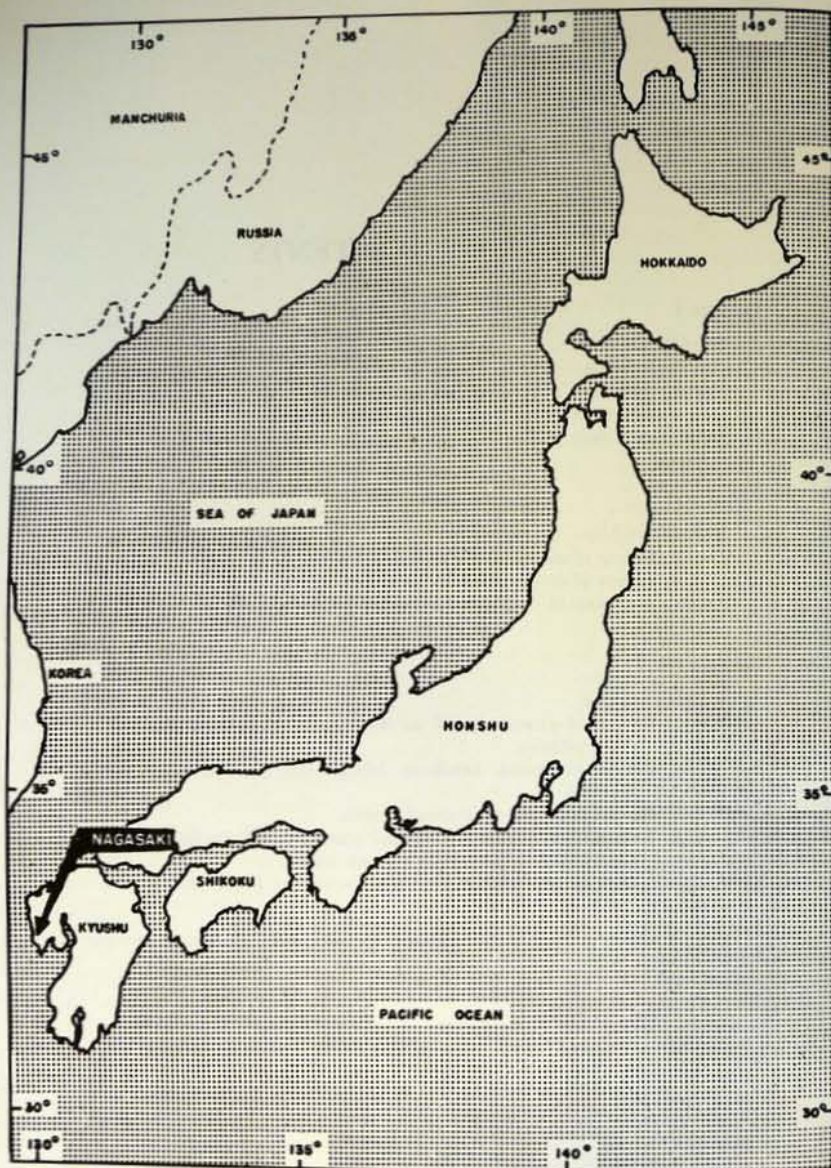
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## INTRODUCTION

1. The atomic bomb attacks in Japan provided an entirely new problem in the studies conducted by the Physical Damage Division of the United States Strategic Bombing Survey. Conventional-type bombing attacks had theretofore been evaluated on the effects of different types of weapons on specific types of buildings and their contents, each weapon or bomb with a destructive effect which was comparatively limited both in scope and degree of damage. In addition, many factors were involved, such as the weight of bomb, type (incendiary or high-explosive), direct hit or near-miss, fuzing, weather conditions, target visibility, visual or radar aiming, night or day attack, and altitude. The success or failure of an air attack depended upon the favorable or unfavorable combination and coordination of several or all of these.

2. With the advent of the atomic bomb came a different kind of attack and a revolutionary weapon which surpassed all known and conventional means of aerial warfare. Its phenomenal results opened up new horizons, new fields of study, the results of which must have far reaching effects on warfare and on military and naval construction of the future. Now, we were concerned with the destructive force of one missile, and one only, on all types of construction. The area of damage, instead of being confined to a few hundred square yards, now encompassed square miles; and damage, instead of being inflicted by a number of bombs falling at different times and places, now occurred in the fraction of a second and from one point. Here was a bomb that destroyed or damaged almost instantaneously by blast, fire, and radiation. And to cause this damage many of the fine points of bombing technique could be disregarded—all that was necessary was to drop and explode the atomic bomb in the vicinity of the

designated target. What followed was almost certain to accomplish the desired result.

3. Many accounts, often fantastic and at times hysterical, have been written about the power of the atomic bomb. Presented in this report are scientific facts, supported by figures, drawings, and photographs, which have been derived from a methodical appraisal on the ground, conducted by experts in the several fields of investigation. Only the shortness of time and the obliteration of evidence have interposed some limitations.

4. Such subjects as, effects of the atomic bomb on industrial structures; on public utilities; on public buildings; on machinery, equipment, and plant utilities; on bridges and transportation systems; and fire damage caused by the atomic bomb are treated in this report. It is believed that sufficient data are contained herein to provide ample source material for assisting greatly in estimating the potentialities of future atomic bomb attacks and for devising necessary and adequate protective measures. Only by profiting from the lessons of the past and by experimenting with future possibilities can planners design structures which will reduce to a comparative minimum the effects of an atomic bomb attack on the industrial and economic life of the United States.

5. A summarization of each of the individual reports will be found in Part I.

6. Reference tables, which follow immediately in this volume and are included in each of the other volumes, cover the following subjects:

- a. Definitions of types of damage and terms applied thereto.
- b. Building types or classifications—Table A.
- c. High-explosive vulnerability classes—Table B.
- d. Fire classification—buildings and contents.

## REFERENCE TABLES

### TYPES OF DAMAGE

#### DAMAGE TO BUILDINGS, INDUSTRIAL AND DOMESTIC

(a) *Structural*.—Damage to principal load-carrying members (trusses, beams, columns, load-bearing walls, floor slabs in multistory buildings) requiring replacement or external support during repairs. Light members such as purlins and rafters are not included.

(b) *Superficial*.—Damage to purlins and other light members; stripping of roofing and non-load-bearing exterior walls. Damage to glass and interior partitions not included.

#### DAMAGE TO MACHINERY, UTILITIES, AND EQUIPMENT

(a) *Total*.—Not worth repair.

(b) *Heavy*.—Requiring repair beyond capacity of normal maintenance. *Staff*.—Usually returned to manufacturer.

(c) *Slight*.—Requiring repair within capacity of normal maintenance staff.

#### DAMAGE TO CONTENTS OTHER THAN MACHINERY AND EQUIPMENT

(a) *Total*.—Not usable.

(b) *Other*.—Usable if reprocessed or repaired.

TABLES A AND B FROM JOINT TARGET GROUP

TABLE A.—Building types or classifications

Group	Type symbol	Description
A. Single-story, no traveling cranes, spans generally less than 75 feet, heights at eaves generally less than 25 feet, area of 10,000 square feet or more.	A1.1	All buildings of this group with saw-tooth roofs other than those included in types A1.2, A1.3, and A1.4.
	A1.2	Frame and roof slab of monolithic reinforced concrete.
	A1.3	Exposed top chords of trusses.
	A1.4	Stressed-skin type of reinforced concrete (e. g., Zeiss Dywidag).
	A2.1	Simple beam and column.
1. With saw-tooth roofs.	A2.2	Arches and rigid frames.
	A2.3	Truss construction.
	A2.4	Frame and roof slab of monolithic reinforced concrete.
	A2.5	Stressed-skin type including concrete shell.
2. Without saw-tooth roofs.	B1	Buildings containing runways for heavy cranes (capacity 25 tons or more); height at eaves generally more than 30 feet.
	B2	All buildings in this group other than those in B1.
	C1.1	Roof trusses supported along one side of building by long span trusses and along other side by columns. Permits large door along 1 side and at ends.
	C1.2	Continuous trusses in 1 or 2 directions; long span in 1 direction, supported by columns or exterior walls and by internal columns.
1. Buildings housing heavy cranes.	C1.3	Exposed chord sawtooth roof buildings; exposed chord trusses supporting major size trusses at 90°. 1 or both truss systems may be of long span.
	C1.4	Diamond mesh arch.
	C2.1	Long-span arches, individually supported along sides of building. May be arranged in multiple spans joined along side.
	C2.2	Long-span, triangular or bowstring trusses, individually supported by columns at sides of building. May be arranged in multiple spans joined along side, using common columns. Roof pitch exceeds 2 in 10.
2. Buildings housing light cranes.	C2.3	Long-span trusses, top chord of pitch 2 in 10 or less, including exposed chord saw-tooth roofs, individually supported by columns along sides of building. May be arranged in multiple spans using common columns or may be continuous over internal columns.
	C3	Stressed-skin including concrete shell construction.
1. Main frame members in 2 directions.	D	This type covers all single-story industrial buildings, regardless of type of construction if under 10,000 square feet in plan area.
	E1	Earthquake-resistant; extremely heavy steel or reinforced-concrete, multistory construction, designed to resist heavy lateral loads.
2. Main frame members in 1 direction only.	E2	Structures in this group other than those in E1.
	F1	Earthquake-resistant, wall-bearing construction. (Walls of brick reinforced concrete, or very massive masonry.)
3. Shell-type construction.	F2	Structures in this group other than those in F1.
	S	Coke ovens, test cells fuel storage, boilers in power plants, etc.
D. All single-story buildings of less than 10,000 square feet plan area.		
E. Multistory frame buildings.		
F. Multistory, wall-bearing buildings. (May have internal columns.)		
S. Special structures.		

TABLE B.—HE vulnerability classes

HE vulnerability class	Structural groups (symbols refer to table A)	HE vulnerability class	Substructural groups (symbols refer to table A)
V1	E1.	V4	A1.1, A1.2, A1.3, A2.1, A2.2, A2.3, A2.4, D.
V2	B1, B2.	V4A	C1.2, C1.3, C1.4, C2.3.
V3	E2, F1.	V5	A1.4, A2.5, C1.1, C2.1, C2.2, C3.
V3A	F2.		

# FIRE CLASSIFICATION—BUILDINGS AND CONTENTS

C—Combustible.—Buildings whose roofs and/or walls are constructed of combustible material. The floors (except the ground floor) are required to be of similar construction. Wood-frame buildings with noncombustible sheeting on roof and/or walls are also included in "combustible" class.

N—Noncombustible.—Buildings which have no significant amount of combustible material in the structure, but whose structure is susceptible to damage by fire in the contents. An example of this type is a building with exposed steel members which may be warped irreparably by the heat of a fire. Roofs of this type are: Corrugated asbestos, corrugated iron, pre-cast or pour-in-place cement or gypsum on exposed steel, and reinforced concrete 2½-inches thick or less.

R—Fire-resistant.—Buildings which have no significant amount of combustible material in the structure and which will withstand all but the most intense fire without structural damage. Roofs and floors (other than ground) should be of concrete more than 2½-inches thick, and the steel frame should be protected and not subject to ordinary fire damage.

C & N, N & R, or C & R used where above types are combined in a single fire division.



"... the power of the atomic bomb is beyond belief."

Nagasaki Prefecture Report

## PART 1

### SUMMARY, GENERAL AND MISCELLANEOUS INFORMATION

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## I. OBJECT OF STUDY

1. The object of the physical damage survey made at Nagasaki, Japan, was to determine and record the extent and nature of damage to buildings, bridges, public utilities, transportation facilities, communications, machine tools and special equipment caused by the atomic bomb attack on 9 August 1945.

2. An appraisal was also made of the accuracy of the damage report prepared by photo-interpretation methods following the dropping of the bomb.

## II. SUMMARY

### A. FOREWORD

1. The survey of Nagasaki was started on 14 October 1945 and was completed on 18 November 1945. The over-all objectives were the collection, analysis, and evaluation of (1) data pertaining to physical damage caused by the detonation of the second atomic bomb ever used in warfare as a military weapon, and (2) data on the similarities and differences between the effects of the atomic bomb and of conventional high-explosive and incendiary bombs with respect to physical damage.

2. The complement of Physical Damage Division Team 2 comprised 13 officers and 8 enlisted men. The photographic group consisting of one warrant officer and 5 enlisted men was furnished by the Regional Headquarters of USSBS. Personnel was drawn from both the Army and the Navy as shown on the following table.

USSBS personnel assigned to Nagasaki

	Physical damage Team 1			USSBS regional headquarters			Aggregate
	Army	Navy	Total	Army	Navy	Total	
Officers	9	4	13	0	0	0	13
Warrant officer	0	0	0	1	0	1	1
Enlisted men	5	3	8	4	1	5	13
Total	14	7	21	5	1	6	27

3. The team conducted a field study and inspection of buildings, machine tools, bridges, public utilities, communications, services, stacks, and materials; gathered statistical and documentary material, including Japanese accounts of the atomic-bomb attack and Japanese damage assessments; and conducted numerous interrogations and interviews of many of the surviving city and

prefectural authorities. Through eye-witness stories, observation of flash-burns on persons and material objects, and cooperative work with other teams, considerable additional information was acquired relative to new effects; i. e., the phenomena resulting from the detonation of a nuclear-fission bomb.

4. This summary is a concise presentation of factual material based on a study and analysis of all reliable data gathered in the field and used in the preparation of Physical Damage Division Report 70. The team was assisted greatly in the collection of information by some 15 officers attached to the British Mission to Japan, who were in Nagasaki for approximately 14 days. A separate report is being issued by that investigating agency.

### B. INTRODUCTION

1. **Highlights.**—At 1102 hours on 9 August 1945, one of two B-29s over Nagasaki dropped the second and last atomic bomb used in the war against Japan. An eye-witness reported:

When the atomic bomb exploded, an intense flash was observed first, as though a large amount of magnesium had been ignited, and the scene grew hazy with white smoke. At the same time at the center of the explosion, and a short while later in other areas, a tremendous roaring sound was heard and a crushing blast wave and intense heat were felt. The people of Nagasaki, even those who lived on the outer edge of the blast, all felt as though they had sustained a direct hit, and the whole city suffered damage such as would have resulted from direct hits everywhere by ordinary bombs.

Exploding in the air approximately 1,700 feet above the Matsuyama district in the Urakami Valley section of the city, this atomic bomb achieved results of greater intensity than the Hiroshima atomic bomb, although they were nei-

ther so widespread nor so numerous because of the topographical features of Nagasaki.

a. As estimated and described by scientists the nuclear-fission bomb had changed into a fire ball hotter than the center of the sun (70,000,000° C.) during the detonation that was over in a millionth of a second.

b. It emitted radiations ranging from beyond the heat bands of infrared, down through the visible spectrum, and into the ultraviolet and penetrating gamma rays.

c. Pressures developed in the bomb were of the order of a thousand-billion times that of the atmosphere.

2. **Effects.**—The paralyzing results of the explosion were as unique and spectacular as the bomb itself.

a. **Buildings.**—Damage to buildings occurred over an area of 1.8 square miles. Structural damage extended from 6,000 to 7,000 feet north and south from GZ and 3,000 to 4,000 feet east and west (to limits of built-up areas). Superficial and minor damage occurred as far as 19,000 feet from GZ.

b. **Bridges.**—Of the 35 bridges at distances varying from 300 feet to 7,650 feet from GZ, 4 were heavily or totally damaged by blast or fire and 6 others suffered structural damage of some nature. Heavy, concrete bridges were the least affected of any.

c. **Stacks.**—Only 4 of the approximately 30 reinforced-concrete stacks within 6,000 feet of GZ were damaged by blast effect of the atomic bomb. All of the steel and brick stacks within this area were totally damaged.

d. **Utilities.**—All public utilities were damaged and disrupted, and for varying lengths of time the city was without gas, electricity (some electric power after 2 days), water (some available for household use after 24 hours), streetcars, and railroad service (48 hours).

e. **Machine tools.**—Damage to machine tools depended largely upon the type of construction housing them. It varied between 5 and 10 percent of total up to 6,000 feet from GZ for all types of buildings except wood frame. In the latter, damage was 95 percent as far as 6,500 feet from GZ. Damage was caused by fire, blast, debris, and exposure.

f. **Fire.**—Combustible debris within 3,000 feet of GZ ignited immediately, and many fires started simultaneously between 3,000 and 6,000 feet. A

conflagration developed which fire fighters were unable to control. A large portion of the fire was attributed to primary causes (radiant heat of the bomb); the remainder was ascribed to secondary causes such as open-flame devices and short circuits.

### C. THE TARGET

1. **The City.**—The city of Nagasaki is located on the western coast of Kyushu in approximately latitude 32°44' N., longitude 129°52' E. An important industrial city, it had a wartime peak population of 288,000 persons, but at the time of the atomic-bomb explosion the figure is estimate to have been 230,000. The city lay on a narrow coastal strip encircling a long, narrow bay and extended up two valleys to the north (Urakami) and northeast (Nakashima) which were separated by a mountain spur.

a. **Built-upness** (percent of roof area to total ground area).—The main residential and commercial districts were intermingled in the two river valleys. The metropolitan area of the city was about 35 square miles, but the heavily built-up area was less than 4 square miles.

b. **Use.**—The Urakami River valley to the north, averaging three-quarters of a mile in width, constituted the industrial zone of Nagasaki, while the wide Nakashima valley contained the main commercial and residential areas of the city.

c. **Climate.**—Nagasaki lies in a semitropical zone strongly influenced by the Asiatic monsoons. The cold northwesterly monsoon produces cloudy days and cold drizzles in the winter, while the warm southerly monsoon in summer brings hot, moist days and a great deal of rain in June and early July. Winter temperatures seldom reach the freezing point and snow is a rarity. Summer temperatures, although not high, are accentuated by the great humidity. Crystal-clear weather prevails in October and early November.

d. **High-explosive attacks.**—Prior to the atomic bomb attack on 9 August 1945, Nagasaki had been subjected to five attacks by high-explosive bombs on the following dates: 10 August 1944, 25 April, 29 July, 31 July, and 1 August 1945. With the exception of damage to the four installations listed below, no high-explosive damage was found in the structures surveyed, although an undetermined number of such bombs fell in the surrounding countryside:

(1) Mitsubishi Steel and Arms plant (Group

26)—damage to structures, negligible; considerable damage to machine tools and equipment.

(2) Structural damage to 3 reinforced-concrete buildings at Nagasaki University Hospital.

(3) Concrete building at boy's normal school (Group 1)—structural damage.

(4) Structural and superficial damage to 2 wood-frame buildings at Asaki School (Group 48).

## D. THE ATOMIC BOMB ATTACK

**1. Meteorological Conditions.**—"The day was clear with not very much wind—an ordinary mid-summer's day." Wind was from the southwest with a velocity of 3 miles per hour. Visibility was unlimited.

**2. Conditions in City.**—"Previously a general alert (warning) had been sounded at 0748, with a raid alert (alarm) at 0750; this was canceled at 0830, and the alertness of the people was dissipated by a great feeling of relief." The city remained on the warning alert and the raid alarm was not given again until 7 minutes after the atomic bomb had exploded. As a result, less than 400 persons were in the tunnel shelters which had capacities totaling approximately 70,000.

**3. The Attack.**—At 1102, 9 August 1945, the atomic bomb which was dropped by one of two B-29s detonated at a height of approximately 1,700 feet over the Matsuyama district in the Urakami Valley section of the city. Although no fire storm developed and the irregular terrain of the city confined the maximum intensity of damage to the Urakami Valley, the area of almost complete devastation equaled 1.8 square miles and casualties, according to the Survey's final estimate, were 35,000 to 40,000 killed and about the same number injured.

## E. ZERO POINTS

**1. Definition.**—The zero point may be defined as the point of detonation of a bomb. If detonation takes place in the air, that point is known as air zero (AZ). The ground location of the point directly under the point of its air burst is designated as ground zero (GZ).

**2. Action of Radiated Heat.**—The heat radiated from the bomb at the time of its explosion was sufficient to cause charring of exposed, unpainted wood within a radius of approximately 1½ miles. The results of this charring action are called "flash burns." The locations of GZ and AZ were developed from flash burns, or rather from the edges

of unscorched surfaces, or "shadows," on otherwise unburned surfaces that were shielded by some object in the path of the heat waves and which afforded directions and elevations for the location of the point of detonation. Figure 2 immediately following Section V of Part 1 shows the location of ground zero.

## F. JAPANESE DWELLINGS

### 1. Vulnerability

a. Japanese dwellings were entirely of wood construction, about 50 percent were one story in height, and the remainder varied from one and one-half to two stories. Footings were of concrete, brick or stone, and most of the roof coverings were hard-burned black tile.

b. Roofs were usually covered with clay tiles, but occasionally a cast-concrete tile, patterned to resemble clay tile, was utilized. In outlying areas a thatched roof was noted in rare instances. Tiles were applied to pitched roofs and were laid on mud over wood sheathing which was carried on heavy wood supports, many of which were hand hewn.

**2. Fire Frequency.**—The fire record in Nagasaki was examined, and the following data are submitted as a matter of interest:

Year	Total number of fires reported	Large fires
1943.....	57	11
1944.....	55	0
1945.....	35	0

<sup>1</sup> 20 dwellings burned.

<sup>2</sup> To 15 Nov.

The fire chief stated that the paid fire department was called upon to fight fires about three times a month. Other fires were extinguished by volunteer associations, and were not reported.

## G. CAUSE AND EXTENT OF FIRE

**1. Conditions Prior to Attack.**—The city plan of residential areas did not follow any European or American pattern. Dwellings were combined with industrial areas, or were clustered in many sections of the city in a hodge-podge manner, being built on terraces, in valleys, and on level ground. Houses were individual, but some sheltered two or three families. They were closely built and, in many areas, particularly toward the center of the city, they adjoined. Comparatively few dwellings

were built subsequently to 1938. Seventy percent of the 3.8 square-mile built-up area was 30 percent or more built up. Main and secondary streets in residential areas were usually 18 feet in width, but many residences were accessible solely by 6-foot-wide footpaths or stone steps leading to narrow terraces.

a. *Fire department.*—(1) Public fire-protection facilities consisted of 1 main and 5 branch fire stations. There were 148 firemen out of the peacetime complement of 248 available for duty. Equipment consisted of 7 combination trucks of 350-gallon-per-minute pumping capacity, manufactured between the years 1937 and 1945.

(2) The auxiliary police and fire units (*Keibodan*), a volunteer group, played an important role in emergency fire fighting, as well as in other matters relative to air-raid defense. The total number of volunteers available for fire fighting activities was 492. This organization maintained 21 motorized combination fire engines, each having a pumping capacity of 350 gallons per minute.

(3) The prefecture office, city office, and principal industrial maintained small private fire brigades and a nominal amount of fire-fighting equipment.

(4) Summarizing the probable effectiveness of the public, volunteer and private fire-fighting services and judging by American standards, the motorized and hand-operated apparatus was antiquated and lacked the high standard of maintenance characteristic of fire departments in the United States.

b. *Water supply.*—(1) The public water supply was obtained from four principal reservoirs and was distributed throughout the city by gravity. On 9 August 1945, the total capacity of all reservoirs was 740,000,000 gallons.

(2) Mains from reservoirs were 28, 22, 20, and 14 inches in diameter. Distribution mains were 10 and 8 inches, and branch lines varied from 6 to 2½ inches. The pressure varied greatly in different parts of the city. In the central portion, the average static pressure was 45 pounds per square inch. Fire hydrants were principally underground.

(3) Great reliance was placed upon the numerous large and small static tanks distributed throughout the city. In addition, there were about 10,000 private wells. Water was available from Nagasaki harbor in unlimited quantities for fire fighting along the shores.

(4) Many small hand pumps had been provided in residential areas and in schools and institutions, but their design was antiquated in comparison with American standards.

c. *Firebreaks.*—The prefecture had completed the establishment of firebreaks (55,000 feet) to reduce possible fire spread in congested areas shortly before 9 August 1945. Buildings of wood construction had been demolished, and much of the debris removed. Dozo (heavy, mud-plaster storage vaults) and masonry structures were left intact. In general, these firebreaks were not sufficiently wide to protect against major conflagrations. A firebreak plan (insert map) shows the areas affected and the extent and width of the breaks. Wide, natural firebreaks in built-up areas were practically nonexistent, except for the bay and river which divided the east and west sections of the city. In the northern part there were no man-made firebreaks, unless the main highway, about 35 feet in width, running north and south, could be considered as a very ineffective one. A river which paralleled this highway farther west and a railroad right-of-way which was nearby were much more effective.

## 2. Ignition of the City and the Conflagration

a. *General.*—The atomic bomb detonated at 1102 hours on 9 August 1945, about 1,700 feet above a point established and indicated on plan in insert map, hereafter designated as ground zero (GZ). Data and information pertaining to the explosion of the atomic bomb and to the start and spread of the fire which followed were obtained from Nagasaki prefecture reports and from interviews. This information is summarized below:

(1) An intense flash marked the detonation of the bomb at 1102 hours 9 August 1945.

(2) A crushing heat wave and blast followed the flash, accompanied by the sound of the explosion which was in the nature of a huge roar.

(3) The degree of heat felt varied considerably in different areas.

(4) The blast completely demolished dwellings and other structures within a radius of ¼ mile from GZ and caused various degrees of damage to other structures within a radius of 2½ miles.

(5) Virtually all living creatures within ¼ mile radius of GZ died instantly from blast pressure and heat, and burns were inflicted on persons in exposed places as far as 5.6 miles from GZ.

(6) Almost immediately following the detonation fires appeared to have started in dwellings,

institutions, and other buildings constructed of combustible materials or containing combustible contents, and in the debris created by the blast effect, within a radius of 3,000 feet from GZ.

(7) Fires beyond 8,000 feet southeast of GZ were caused largely by fire spread.

b. *Fire department.*—The paid and volunteer fire departments were unable to cope with the conflagration. In some sections, however, bucket brigades effectively retarded the progress of the conflagration.

c. *Water supply.*—The public water supply failed. The pressure was low (30 pounds) at the time, but fell to 10 pounds per square inch and, by 0430 hours, 10 August it was negligible. In the Urakami area toward the north, there were 5 breaks in buried pipes, and that area was totally without water from the time of the detonation. Breaks in 11 water mains and in about 5,000 house service lines caused the over-all failure of the system. Water in static tanks was soon exhausted.

d. *Fire spread.*—Fires spread by progressive conflagration toward the north, east, and west from GZ, and were exceedingly difficult to trace. The built-upness (percent of roof area to total ground area) in these areas, especially beyond 2,000 feet of GZ, was erratic, dwellings being clustered in valleys and here and there on terraces and hillsides. The built-up area, 6,000 to 8,000 feet south and southeast of GZ, was much more uniform. Interrogation disclosed that, irrespective of the direction of the wind (southwest to northeast), fire spread south and southeastward, swept up hillsides, and burned buildings already damaged or collapsed by the blast. This phenomenon occurred 7,000 to 8,000 feet from GZ and within 2 to 3 hours after the detonation. At 8,000 to 11,000 feet south and southeast of GZ, fires were started at the time of the blast in some of the buildings and, as these buildings burned, spread to others in the vicinity.

e. *Extinguishment of fires.*—The chief of the Nagasaki fire department stated that fires were under control by 0600 hours on 10 August. The fire finally burned itself out by the evening of 11 August except in the Urakami District where isolated fires burned until 12 August. There was no evidence that fires restarted once they had burned themselves out or had been extinguished by other means.

3. *Value of Firebreaks.*—In most instances,

narrow man-made firebreaks were ineffective. There were two known cases where the existence of a firebreak, coupled with bucket-brigade activity, prevented fire spread.

#### 4. Fire Damage

##### a. Urban damage.

	Superficial	Structural
Fire only.....		1,376,000 square feet (or 0.049 square mile).
Fire and blast (mixed).....		21,087,000 square feet (or 0.864 square mile).
Blast only.....	8,536,000 square feet (or 0.306 square mile).	2,701,000 square feet (or 0.096 square mile).
Total.....	8,536,000 square feet (or 0.306 square mile).	28,164,000 square feet (or 1.009 square miles).

Total damage: 36,700,000 square feet (or 1,316 square miles).

Total area of Nagasaki: 91,800,000 square feet (or 3.3 square miles).

b. *Specific groups.*—An analysis has been made of the damage to specific groups. This analysis appears in the appendix to this part (tables preceding Part 2). A summary of the damage is given below. The buildings include reinforced-concrete, light and heavy steel, brick load-bearing, and wood-frame. Occupancies include heavy and light machine shops, storage, offices, and public buildings.

Total number of buildings (other than dwellings).....	567
Total plan area (square feet).....	5,510,000
Total usable floor area (square feet).....	7,329,000

##### c. Damage in square feet.

	Destroyed	Structural	Superficial	Minor
Blast.....	889,000	299,000	479,000	974,000
Blast and fire.....	1,252,000	126,000	24,000	287,000
Fire alone (buildings).....	29,000	20,000		69,000
Fire contents.....	1,630,000	16,000		

d. *Japanese statistics.*—The prefecture reported a total of 20,686 dwellings damaged or destroyed. 1,500 wood light poles burned, one wood bridge destroyed by blast and fire. As of 1 September 1945, the identified dead numbered 19,743, the missing 1,927, and the seriously and slightly wounded numbered 40,993. The total number of sufferers, including persons made homeless, was 89,780.

e. *Bridges.*—Bridges of masonry construction

were not susceptible to fire damage, but a combustible bridge, 5,460 feet from GZ, was destroyed by blast and fire. Railroad bridges were principally of steel-plate girder type. There was evidence of the burning of the ties or stringers on one railroad bridge 1,650 feet from GZ. A separate volume contains details of bridge structures.

#### 5. Protective measures

a. The Japanese government had ordered the removal of all combustible material from attics, this policy being enforced by police inspection. The prefecture had ordered the removal of ceilings in dwellings, and parts of ceilings in commercial, industrial, and public buildings, in order to expose combustible roofs and supports for more efficacious fire control, and apparently this directive was obeyed.

b. The national government had also requested that all stoves and open-flame devices, particularly those in dwellings, be extinguished when air-raid alerts were sounded. The police endeavored to enforce this request, and the fire chief stated that, in general, observance was good.

c. Although these precautions were constructive, little or no attempt was made, apparently, to eliminate surplus combustible material. Small stores were littered with it; wood, charcoal, and other odds and ends were always present in dwellings; pieces of wood, old papers, and discarded furnishings were often placed under the floors; and piles of combustible material were noted stacked against the outside walls of buildings.

#### H. SUMMARY OF DAMAGE TO BUILDINGS

##### 1. Extent of Damage

a. The damage to buildings caused by the atomic bomb in Nagasaki extended over an area of 1.8 square miles, including both residential and industrial sections. The area was irregular in shape and the fringe of the damaged area was at greatly varying distances from GZ.

b. Structural damage caused by blast alone extended approximately equal distances (between 6,000 feet and 7,000 feet) in a northerly and southerly direction from GZ. Structural damage occurred to the limits of the built-up areas to the east and west, approximately 3,000 feet and 4,000 feet, respectively.

c. Superficial and minor damage caused by blast alone extended as far as 19,000 feet south of GZ along the edge of Nagasaki harbor, and minor

damage, consisting of broken window glass and disturbed tile roofing, occurred to buildings in the many valleys protected from the direct blast of the bomb.

#### 2. Cause of Damage

a. The principal causes of damage to structures in Nagasaki were blast, fire, and blast and fire combined. As was to be expected from a non-cratering bomb, no evidence was found of earth-shock damage to buildings.

b. Damage to special-type buildings caused by blast or fire is described in Parts 2 and 3 of this report. Damage caused by fire alone to special-type buildings and to residential areas is described in Part 7.

#### 3. Effect of Distance from GZ on Degree of Damage to Structures

a. Reference is made to Table 1 showing the number of buildings of different types surveyed at varying distances from GZ, the total floor areas of these buildings, and the floor areas affected by the atomic bomb. All areas are given in thousands of square feet. The figures under the heading "Destroyed" indicate areas in which structures could not be repaired, while those under "Structural damage" indicate areas in which structures would require major repairs to make them usable.

b. Although the degree of damage decreased as the distance from GZ increased, the rate of decrease was not uniform in similar types of buildings as their relative position from GZ increased. This variation was due to two causes:

(1) Quality and workmanship varied greatly in similar types of buildings.

(2) In some cases an insufficient number of buildings of the same general types was exposed to the effects of the bomb at similar distances from GZ to obtain reliable estimates of the damage which might be expected.

c. In an area between 2,000 and 3,000 feet from GZ only 9.5 percent of the floor area of reinforced-concrete buildings was destroyed beyond repair or was structurally damaged; while in an area between 4,000 feet and 5,000 feet from GZ 50 percent of the floor area of reinforced-concrete structures was destroyed or structurally damaged. This wide variation in percentage of damage is because of the fact that the majority of reinforced-concrete buildings in the 2,000- to 3,000-foot area were of excellent materials and earthquake-resistant design (University Hospital, Group 20) with

very heavy concrete beams, girders, and floor and roof slabs. Three buildings in the 4,000- to 5,000-foot area (Buildings 29, 30, and 31 in Group 26) were of different construction with thin arched roofs which were comparatively susceptible to blast. As these buildings were of concrete and reinforced with steel bars they are included under "Reinforced-concrete" in Table 1. Most of the damage to reinforced-concrete buildings shown under the headings "Destroyed" and "Structurally damaged" between 4,000 feet and 5,000 feet occurred in these three buildings.

d. In an area between 2,000 feet and 3,000 feet from GZ only one building constructed with load-bearing walls was subjected to the effects of the atomic bomb. Obviously, a greater number of buildings of this type would have been needed to give a higher degree of reliability in estimating the extent of damage which might be expected.

e. For further information regarding the damage caused by blast, fire, and combined blast and fire, reference is made to the appendix in this part (tables preceding Part 2). The damage analysis tabulation shows the extent of fire damage to contents as well as all types of damage to structures, and segregates the damage in buildings according to their fire-resistive qualities and their distances from GZ.

#### 4. Effect of High-Explosive Bombs on Structures (prior to 9 August 1945)

a. Prior to the atomic bomb attack on 9 August 1945, Nagasaki had been subjected to five attacks by planes carrying high-explosive bombs. These attacks occurred on 10 August 1944, and 25 April, 20 July, 31 July, and 1 August 1945. The only industrial installation which suffered severe structural damage was the Akunoura Engine Works (Group 52) which was at such a distance from GZ that little if any additional damage was caused there by the atomic bomb. The bombs which fell in the Mitsubishi steel and arms plant (Group 26) caused considerable damage to machine tools and equipment, but the damage to the structure which housed them was negligible in relation to the size of the plant. The damage caused by these bombs contributed very little to the over-all damage caused by the atomic bomb.

b. Three reinforced-concrete buildings at the Nagasaki University Hospital were struck by high-explosive bombs causing structural damage to each of them. This damage was easily distin-

guishable from the comparatively minor structural damage caused by the atomic bomb.

c. The concrete building at the boy's normal school (Group 1) was struck by one high-explosive bomb which caused structural damage. This too could be distinguished from minor damage caused by the atomic bomb.

d. Two high-explosive bombs at Asaki school (Group 48) caused structural and superficial damage to two wood-frame buildings.

e. With the exception of these four installations, no high-explosive damage was found in the structures surveyed, although an undetermined number of such bombs fell in the surrounding open country.

#### 5. Vulnerability of Structures to the Atomic Bomb.

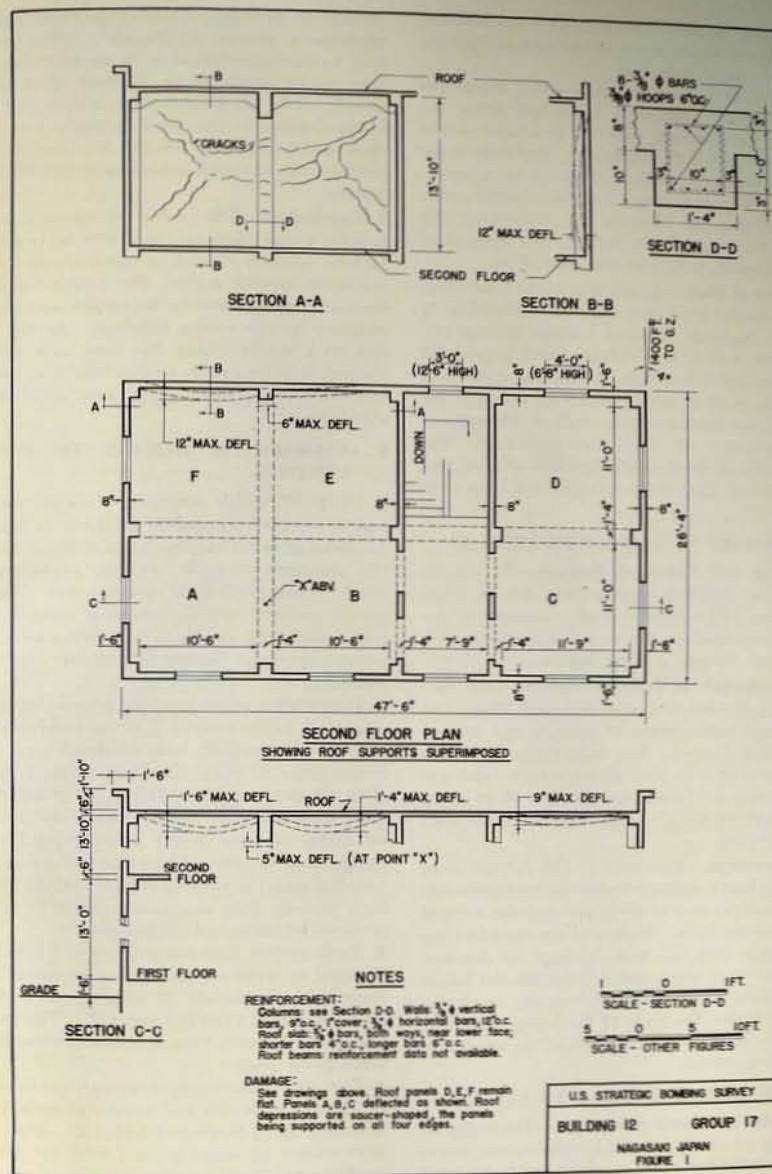
The degree of damage to buildings varied according to their relative distance from GZ, the materials of which the buildings were constructed, the design of the buildings, the relation of the long axes of the buildings to GZ, and the shielding effect of hills or man-made structures.

a. The variation in degree of damage depending on distance from GZ is illustrated in Table 1.

b. Generally, buildings of reinforced concrete were less susceptible to the effects of the bomb than those of industrial type, steel-frame construction or buildings with load-bearing masonry walls. Wood-frame buildings were the most easily destroyed, and, in addition, had the properties which made entire destruction by fire possible. Steel-frame structures, roofed or sided with corrugated asbestos, suffered less structural damage than those covered with corrugated iron or sheet metal. The corrugated asbestos crumbled easily and the blast pressure equalized itself rapidly around the main framing members, while the steel siding transferred the pressure to the structural members, causing general collapse.

c. Variations in design caused different degrees of damage to buildings in the same general building classification. Some specially designed concrete structures built to withstand earthquakes with heavy beams, well-placed steel reinforcing, and haunches between columns and beams withstood the blast pressures at relatively short distance—as close as 1,200 feet from GZ. Steel-frame buildings with pitched monitor-type roofs, especially those with knee braces extending from roof members to a point below the eaves on the columns, suffered less damage than structures with saw-tooth roof framing.

d. Structures of all kinds with their long axes



parallel to the force of the blast were less deformed than those which received the pressure on the greater area of their sides.

*e.* Due to the height of the point of detonation of the bomb (estimated 1,700 feet above sea level), the screening effect of structures within 5,000 feet of GZ was negligible. Buildings in the Nakashima valley, which extended in a north-easterly direction from Nagasaki harbor, were shielded from the blast by the intervening hills which rose to heights of 900 feet at a distance of approximately 6,000 feet southeast of GZ.

**6. Effect of Blast.**—An example of the blast effect of the atomic bomb was observed on Building 12 at the Nagasaki Medical College (Group 17). The west wall of this building faced toward GZ and was 1,400 feet from it. It was 2,200 feet from the point of detonation of the bomb in the air, and the blast struck the wall at an angle of approximately 50° from the horizontal. The dimensions of the concrete members affected and the amount they were deflected are shown on Figure 1.

## I. SUMMARY OF DAMAGE TO BRIDGES

**1. Extent and Cause of Damage.**—Of the 35 bridges at distances varying from 300 to 7,650 feet from GZ, 4 were seriously damaged or destroyed by blast or fire and 6 others sustained structural damage of some nature.

**2. Construction of Bridges.**—Bridges were constructed of reinforced concrete, steel, stone, and wood, and combinations of concrete and steel or concrete and wood. The main types of bridges were masonry arch, plate girder, concrete slab and girder, open steel truss, and timber. Short spans were used extensively, the maximum single span being 120 feet.

**3. Conclusions.**—Proximity to GZ did not seem to affect heavy concrete bridges seriously, possibly because of the mass of the bridge and the vertical action of the blast. Bridges of less mass but farther away from GZ were damaged by displacement sideways which caused distortion and failure of members. It is difficult to form any conclusion as to whether the angle of the bridge centerline with the blast direction influenced the amount of damage sustained.

## J. SUMMARY OF DAMAGE TO STACKS

**1. Extent and Cause of Damage.**—The negligible amount of damage to reinforced-concrete stacks within 6,000 feet of GZ, as compared to the great

damage to buildings, is one of the most unusual phenomena present at Nagasaki. Damage to only 4 out of approximately 30 stacks within this area can be attributed to the blast effect of the atomic bomb. It is interesting to note that two of the four stacks that were damaged were very close to high-explosive hits and it is possible that this fact may have had something to do with these failures.

**2. Conclusions.**—The ability of concrete stacks to resist atomic blast may be attributed to several factors; namely, flexibility, streamlining effect, minimum exposed surface, fire resistive quality, vertical angle of blast to the surface and partial shielding by intervening buildings. As the steel and brick stacks within this area were all destroyed, it is reasonable to conclude that the reinforced-concrete stack is the most resistant to atomic blast.

## K. SUMMARY OF DAMAGE TO PUBLIC UTILITIES

**1.** The public utility systems in Nagasaki were in many respects comparable to those in smaller American cities with a population of about 30,000. One exception, however, was the sewer system which consisted entirely of open trenches. Underground conduits carrying electrical utilities were nonexistent. All wires and most cables were supported by wood, reinforced-concrete or steel standards.

**2.** Direct blast effect was the primary cause of damage to public utilities. It was extremely destructive to standards with overhead wires and, in particular, to wood standards within a radius of 10,000 feet from GZ. The points of failure on these standards were usually within one-third to two-thirds of their height above ground level. Bridges bearing railroad and streetcar tracks sustained damage in varying degrees, partly by oblique pressure from above, and partly by lateral pressures which caused displacement.

**3.** Earth surface depressions of up to 1 foot were observed at scattered points in a reclaimed area covering approximately 50 acres and at a maximum distance of 2,000 feet from GZ. This caused a series of failures in 12-inch cast-iron water pipes 3 feet below grade.

**4.** Fire, a secondary cause of damage, was observed on railroad cross ties and wood standards intermittently up to 10,000 feet from GZ. Most fires were caused by direct contact with the general conflagration in the area. Varying degrees of

Distance from GZ (feet)	Heavy steel					Light steel			
	Total No.	Total floor area	Destroyed	Structural damage	Superficial damage	Total No.	Total floor area	Destroyed	Structural damage
0 to 1,000									
1,000 to 2,000	6	145	67	78		2	22	11	6
2,000 to 3,000	1	15		6	9	2	9	5	
3,000 to 4,000	10	183	36	26	64	1	10	10	
4,000 to 5,000	10	427	190		68	14	518	363	45
5,000 to 6,000	2	165	33		90	5	154	33	9
6,000 to 7,000						4	18	2	
7,000 to 8,000						1	10		
8,000 to 9,000									
9,000 to 10,000						1	92		
10,000 to 11,000	6	203			29				
11,000 to 12,000	8	65			15	18	443		
12,000 to 13,000	1	3				1	1		
13,000 to 14,000	3	63			6	4	384		
14,000 to 15,000	4	12			9				
15,000 to 16,000	10	651			17	1	16		
16,000 to 17,000						3	40		
17,000 to 18,000									
18,000 to 19,000						9	11		
19,000 to 20,000									
Total	61	1,932	326	110	237	66	1,728	424	60

\*See par. 8 of summary of damage to structures.

NOTE.—All areas in thousands of square feet. "Destroyed" indicates damage beyond repair.

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#### Telephone

- (1) Total length of underground cables, 148.8 miles, heavily damaged, 16.1 miles—10.8 percent.
- (2) Total length of aerial cables, 49.0 miles, heavily damaged, 30.4 miles—62 percent.
- (3) Total length of open wires, 62.7 miles; heavily damaged, 26.7 miles—43 percent.
- (4) Subscribers telephones, 4,891 sets; destroyed and heavily damaged, 2,920—60 percent.

#### Telegraph

- (5) Total length of open wires, 128.3 miles; damaged in various degrees, 19.2 miles—15 percent.
- (6) Estimated repair time was 100,000 man-hours (telephone and telegraph systems).

**9. Street Railway System.**—A double-track street railway system transported a daily load of 77,000 commuters. The overhead power lines with a potential of 600 volts, direct current, were supported by steel standards.

- a. The damage to the system was as follows:
  - (1) Thirty-nine cars (all within 3,000 feet of GZ) were damaged by blast and fire (70 percent).
  - (2) Six thousand three hundred and thirty-two feet of track were damaged due to burned sleepers which caused the rails to buckle. The fire was probably secondary and due to burning debris (4 percent).
  - (3) Thirty-one thousand four hundred and ninety-six feet of trolley wire were blown down by blast (75 percent).
  - (4) Eight thousand two hundred and two feet of power lines were torn down and 24,606 feet of electric light wires were damaged (75 percent).

#### 11. Summary Public Utilities Damage

System	Max. dist. from GZ for damage	Damage cause	Over-all damage (percent)	Repair time (man-hours)	Parts damaged
Electric	10,500	Blast and fire	35	75,000	Substations, one power station, transmission and distribution systems.
Gas	7,000	Blast	Production 100; system 20.	200,000	Holders, producers, main lines.
Water	10,000	Blast	Production 20; system 20.	50,000	Mains, station, vent meters.
Communications	10,000	Blast and fire	40	75,000	Open wires and aerial cables, and telephone apparatus.
Transportation	10,000	Blast and fire	Street railway 50; railroad 20.	Street railway 200,000; railroad 100,000	Track, bridges, overhead wires, standards, and stations.

- (5) Five percent of the total number of steel supports for overhead power lines were sheared off or overturned.

b. Estimated time to complete repair was 200,000 man-hours.

**10. Railroad.**—Railroad facilities consisted of a single-track line running due north within the city, connecting it with Tosu Junction. This line terminated at the Nagasaki station and served three other secondary stations within the city limits. Many passengers utilized this road as a means of transportation within the city and its suburbs.

a. Although the damage to equipment was not extensive, it was severe enough to curtail traffic for 48 hours, during which time sufficient emergency repair work was effected to resume limited operations. The major damage was sustained by the track and railroad bridges. The wooden cross-ties were burned intermittently for a distance of 10,000 to 15,000 feet from GZ, causing the rails to buckle at these points. The fire was secondary resulting from contact with burning debris. Three bridges were displaced, distorting the rails and necessitating complete rebuilding of the tracks. The railroad stations were 100 percent structurally damaged by blast and fire and the electric signal system was severely damaged. Rolling stock sustained damage, primarily by blast.

b. In order to rebuild the station buildings and repair all the damage to tracks and signal systems, it was estimated that 100,000 man-hours would be required.

#### L. SUMMARY OF DAMAGE TO MACHINE TOOLS

1. The industrial installations in Nagasaki (Insert Map) consisted of 286 structures in 21 groups, situated between 5,000 feet north and 20,000 feet south of GZ. The total floor space utilized for processing and storage was 5,400,000 square feet, distributed in the several structural types as follows:

- a. Heavy steel-frame, 34 percent of total area.
- b. Light steel-frame, 32 percent of total area.
- c. Reinforced-concrete, 12 percent of total area.
- d. Mixed reinforced-concrete and steel-frame, 5 percent of total area.
- e. Brick-wall (plant transformers and oxygen producer equipment), 6 percent of total area.
- f. Wood-frame, 11 percent of total area.

2. No damage to machinery and equipment by the atomic bomb recorded outside a radius of 6,500 feet from GZ, but within this radius 1,834 machines and approximately 450 pieces of major equipment were contained in 16 building groups. The distribution of these machines and equipment in the different structures was as follows:

- a. Heavy and light steel-frame:
  - 922 machines, 50 percent of total number.
  - 338 equipment, 75 percent of total number.
- b. Reinforced-concrete:
  - 410 machines, 22 percent of total number.
  - 90 equipment, 20 percent of total number.
- c. Wood-frame:
  - 502 machines, 27 percent of total number.
  - 22 equipment, 5 percent of total number.

3. The relation between the percentage of structural damage to buildings and the percentage of damage to tools and equipment was found to be:

Relationship between structural and equipment damage

Structural types	Maximum distance from GZ for damage (feet)	Structural damage (percent)	Interior fire damage (percent)	Machine tool and equipment damage (percent)
(1) Steel-frame (heavy and light)	5,600	65	1	21
(2) Reinforced-concrete	4,700			
(a) Schools (temporary)		75	80	21.5
(b) Industrial		100	1	45
(3) Wood-frame (temporary)	5,600	100	85	95

<sup>1</sup> Three buildings.

4. **Machinery in Steel Buildings.**—The maximum range in which damage occurred to industrial steel-

frame structures was 5,600 feet. The structural damage within this range was 65 percent, caused chiefly by blast. Fires were negligible and caused only slight damage.

5. Nine hundred twenty-two machines and 338 pieces of equipment were installed in these buildings. Of these, 21 percent of the machines and 36 percent of the equipment sustained damage of varying degrees. Causes of damage were:

- (1) Debris (primarily lateral movement of whole structure causing overturning of machines), 70 percent.
- (2) Weather, 27 percent.
- (3) Fire (burned electric motors), 3 percent.

6. Weather damage could have been avoided by simple temporary coverings. Of all damaged machinery, 60 percent could have been repaired by plant maintenance crews, so that production would not have been seriously impeded. The remainder was heavily or totally damaged.

7. Damage to auxiliary equipment (furnace, cranes, gas-producer plants) and to plant utilities amounted to 45 percent. These units were generally of lighter construction than the fixed machines and presented larger surface areas to the blast. Electric wires and standards were displaced by blast. Gas and water pipes were broken and displaced by collapsing structures. Small tools such as drills, dies, taps were scattered about by the blast, and subsequently suffered weather damage amounting to 65 percent. Raw materials and semi-finished products suffered varying degrees of damage primarily from blast and weather.

8. The effective damage may be summarized as follows:

- a. Machine tools, 21 percent.
- b. Equipment, 45 percent.
- c. Small tools, 65 percent.
- d. Utilities, 45 percent.
- e. Raw materials and semifinished products, 10 percent.

9. In spite of the relatively small percentage of damage to primary equipment, losses of other items would have caused a complete shutdown for 4 months (Japanese estimate) before 50 percent of production could have been resumed.

**10. Machinery in Reinforced-Concrete Buildings.**—No reinforced-concrete buildings were structurally damaged or had their contents damaged beyond 4,700 feet from GZ. Twenty-seven buildings, one of which was of mixed rein-

forced-concrete-and-steel-frame construction, were situated within this area. They sustained 75 percent structural damage by blast and 90 percent interior fire damage. Four hundred and ten machine tools were installed in these buildings of which 147 or 36 percent sustained damage. Causes of damage were:

a. Debris (collapsed parts of the structures), 80 percent.

b. Weather, 11 percent.

c. Fire (mostly caused by the burning of interior trim), 9 percent.

11. Debris accounted for more damage in these structures than in steel-frame buildings. It is interesting to note that the percentage of machines damaged by fire was only 9 percent in spite of widespread fires in the building interiors. Electric installations were demolished by fire in contrast to gas and water lines which sustained only slight damage. Damage to small tools was caused by blast and fire and amounted to 45 percent. Raw materials and semifinished products sustained 10 percent damage. The effective damage may be summarized as follows:

	Percent
Machine tools	36
Equipment	30
Small tools	45
Utilities	65
Raw materials and semifinished products	10

12. Machinery in Wooden Buildings.—Seven groups with 14 wood-frame buildings were situated within 6,500 feet of GZ. They were all destroyed by blast and fire. These groups were utilized as temporary auxiliary machine shops for industrial plants. Their importance to production was relatively small, and their destruction was not of serious consequence. Five hundred and two machines were installed in these structures, 476 or 95 percent of which suffered damage. Fifty-four percent of this damage was due to exposure to the elements. Fire damage amounted to 10 percent and debris accounted for 26 percent of the total damage. Blast and a combination of blast, fire and debris damaged 10 percent of the machines. Plant utilities were made unusable by blast. Small tools and raw materials sustained 100 percent damage from blast and exposure to the elements.

### 13. Relations Between Damage to Buildings and Machinery Therein

a. The relations determined between the damage to wood-frame and steel-frame structures and

the machinery contained therein (Pt. 5, Par. 3) should be sufficiently accurate to be applicable in predicting the effect of the bomb in any attack by or on the United States in the future. There were enough examples of damage in these building types to give a sound basis for the figures presented here.

b. The relation between damage to reinforced-concrete industrial buildings and the machinery therein is not of the same order of reliability. The high percentage of damage to machine tools in reinforced-concrete buildings was due primarily to the 100 percent damage in the collapsed sections of Buildings 29 and 31 in Group 26. These were reinforced-concrete, stressed-skin structures designed for industrial use but relatively much weaker structurally than the other reinforced-concrete buildings in the area. Conclusions based on the damage found in the school buildings alone would be more accurate. Therefore, a relation has been estimated (Pt. 5, Sec. II, Par. 9) in an attempt to allow for these variations in construction and the resultant inconsistencies in machine tool damage. This estimate attempts to present an idea of the damage which would have been sustained by the tools in the buildings which collapsed if (1) the roofs of the buildings had not fallen upon the tools, so that the sources of damage would have been limited to blast entering the windows and doors, and to fires which might possibly have started; or if (2) the same tools had been installed in heavier reinforced-concrete buildings, such as were used for the schools.

14. Table II is a summary of the damage sustained by the contents of the industrial plants in Nagasaki when the atomic bomb detonated 1,700 feet above the ground.

15. By comparing the structural types surveyed with average industrial plants in the United States, it can be reasonably deduced that the following damage might be expected, were an atomic bomb detonated above such plants:

Damage in percentage (of total)

	Max. radius from GZ (feet)	Machine tools	Equipment	Utilities	Small tools	Raw materials and semifinished products
(1) Steel-frame, heavy	5,000	5	30	30	50	10
(2) Steel-frame, light	6,000	10	45	45	65	10
(3) Reinforced-concrete	4,700	5	30	30	50	10
(4) Mixed reinforced-concrete-and-steel frame	5,500	10	35	45	65	10
(5) Wood-frame	6,500	95	100	100	100	100

16. In both steel-frame and reinforced-concrete buildings there were heavy losses in small tools and small finished and semifinished products when these objects were scattered about by blast and exposed to damage by the weather. Although there would undoubtedly be heavy damage to these items if a plant in the United States were attacked with an atomic bomb, the practices followed here in storing such materials would reduce the losses to a point considerably below that found in Nagasaki.

17. The maximum distance from GZ at which machine tools and equipment were damaged was 6,500 feet. Overhead electric power and telephone lines in plants were, however, in a few instances, blown down as far away as 12,000 feet.

18. Prior to 9 August 1945, Nagasaki was attacked several times with conventional-type bombs. The damage caused by these attacks was readily identified and isolated from the atomic bomb damage. The most serious attack was that of 1 August 1945, in which the boiler shop and foundry belonging to Mitsubishi Engine Works at Akunoura were damaged. This attack also partly paralyzed production in the Mitsubishi Steel Works by scoring a direct hit on the hydraulic equipment for heavy presses. The foundry shop at the Akunoura Engine Works received 6 direct hits, probably with 500-pound, general-purpose bombs, thereby destroying one cupola and displacing a heavy overhead crane. The boiler shop, containing 88 machines, received 8 direct hits. Two machines were destroyed and 10 were heavily damaged by blast and fragments. Twelve machines were slightly damaged by blast and fragments. The fraction of machines damaged was 27 percent.

19. A total of 22 bomb hits was identified within the steel plant area. The bombs ranged from 500-pound to 2,000-pound general-purpose. The most important damage to machinery in this plant was that to the hydraulic press equipment, vital in the processing of heavy forgings. A 1,000-pound general-purpose bomb scored a direct hit, upsetting and cracking the equipment. It was estimated by plant officials that 6 to 8 weeks would have been required for repairs before operation of this part of the plant could have been resumed.

20. The ships and dock yards were subjected to several attacks which caused some damage. General-purpose bombs varying in size from 500 pounds to 2,000 pounds were used in these

attacks. Plant officials estimated the total damage sustained in the several attacks to be:

	Percent
Machinery and equipment damage	7.9
Building damage	18.8
Plant utilities	15.0
Raw material, finished, and semi-finished products	6.0

These percentages were found by the team to be correct.

### 21. Comparison of Damage to Machine Tools and Utilities by the Atomic Bomb and High-Explosive Bombs.

—Inspection and analysis of the damage inflicted on machine tools in Nagasaki by the atomic bomb and comparison of the findings with what was already known of the effects of high-explosive bombs on machine tools brought out one definite point. High-explosive bombs exploding in a building containing machine tools damaged the tools by more or less direct action; that is, fragments of the bomb itself, earth shock from the cratering of the bomb, or pure blast damaged the tools. Damage to the building was incidental to this damage unless the tools were damaged by debris, by falling structural members or by the burning of the building or its contents. The atomic bomb, on the other hand, damaged most of the machine tools by indirect action. A few tools were overturned by the blast, but almost all of the serious damage was caused by debris from damaged buildings or by the burning of the buildings. Damage to machine tools by the atomic bomb is, therefore, very closely related to the type of building in which they are housed and to the effects of the bomb on that building. Even the subsequent damage to tools by exposure to the weather is related to the degree of damage suffered by the buildings which housed the tools. All of the damage to machine tools has been summarized in Table II, together with the data on the types of buildings which housed the tools and the degree of damage suffered by each building, so that the relation between building damage and machine tool damage can be analyzed.

22. The Japanese practice of putting electric power, gas, and water lines above ground resulted in great damage to the plant utilities. The lines were either blown down by the blast of the bomb or pulled down by distorted and collapsing buildings. Auxiliary equipment was also of such a nature that it was seriously affected by damage to the buildings.

TABLE II.—Summary damage analysis—machine tool

Number of buildings	Maximum distance from GZ (feet)	Structural damage		Machine type	Number of machines before attack	Number of machines damaged	Damage cause												Remarks				
		Cause	Degree (percent)				Fire				Blast				Combination					Elements			
							D	HD	SD	D	HD	SD	D	HD	SD	D	HD	SD		D	HD	SD	
14	6,500	Blast and fire	100	Light	502	476	56	18	23	7	10	98	10	4	17	13	2	7	258-34	218	Wood structures.		
19	5,000	Blast	65	Light and heavy	922	184	20	5	—	—	32	37	41	—	—	—	—	—	49	—	Steel frame.		
8	4,700	Blast and fire	75	Light and heavy	410	147	36	10	3	—	38	23	26	—	—	—	—	9	12	—	Reinforced concrete.		
27	5,000	Blast and fire	—	Light and heavy	1,352	331	25	18	—	—	117	80	75	—	—	—	—	17-11	—	—	Structures.		
41	6,500	Blast and fire	—	Light and heavy	1,853	807	44	60	—	—	273	46	40	—	—	—	—	66-29	—	—	Steel-frame structures.		
27	6,500	Blast and fire	70	Equipment, auxiliary and fixed, small tools	450	266	48	3	—	—	—	—	—	—	—	—	—	234-40	—	—	Reinforced concrete.		
27	6,500	Blast and fire	—	—	—	65	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Types of all structures.		
27	6,500	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	Do.		

Group 35, Mitsubishi woodworking plant, contained 21 machines which were all destroyed by fire. This group was the only building among the steel-frame structures with combustible interior. This damage is not included in the final percentage of fire damage to machinery.

D—Destroyed. HD—Heavily damaged. SD—Slightly damaged.

23. Although the fraction of damage to machine tools was low (24 percent) and much of this damage was slight, the over-all effect of the bomb on machines, equipment, and utilities was so great as completely to paralyze production in many of the plants for a very long period and to cause reduced production for many months.

## M. PHOTOGRAPHIC INTERPRETATION

**1. Damage Evaluation.**—The damage to Nagasaki resulting from the atomic bomb attack of 9 August 1945 is the subject of a report issued by the Physical Vulnerability Section of the Joint Target Group. This report was based on a study of photographs taken in photographic sortie 3PR-5M396 (13 August 1945). Comparison of damage assessed by means of photo interpretations with that determined by ground survey leads to certain general conclusions regarding the capabilities and limitations of photo interpretation with respect to atomic bomb damage, such as:

a. *Residential buildings.*—(1) The area of residential-type buildings totally damaged by the atomic bomb was accurately determined, but the cause or causes of the damage (blast or fire) could not be determined.

(2) The surrounding area of heavily damaged buildings was detected, but the degree of damage was not accurately defined.

(3) The degree of damage in buildings which suffered only superficial damage was likewise not accurately estimated.

(4) Fires which spread beyond the area of heavy damage could have been detected but were not.

b. *Industrial buildings.*—(1) *Steel- or timber-frame buildings.*—(a) Photo interpretation can assess extent and severity of damage to these buildings within reasonable limits of accuracy.

(b) Presence of fire can be detected provided interpreters are trained to distinguish between fire effects and blast effects of the atomic bomb.

(c) It cannot be assumed that the contents of a structurally damaged building have suffered damage unless it is ascertained from photos that the building has collapsed, has been so distorted as to damage tools near the walls, or that a floor has fallen.

(d) Evidence of removal of machinery or of emergency coverings over exposed pieces has a direct relation to the extent of damage suffered by machinery from weather exposure.

(2) *Reinforced-concrete buildings.*—(a) Structural

damage to reinforced-concrete buildings constructed with steel or timber roof trusses is visible on aerial photographs.

(b) Earthquake-resistant buildings show little evidence of damage unless it has been serious enough to cause collapse.

(c) Attempts to evaluate damage to interiors of reinforced-concrete buildings based upon their proximity to GZ are affected by so many variables that they are almost valueless. Photo interpretation cannot estimate interior damage to these structures.

e. *Common error.*—There was a general tendency of photo interpreters to attribute too much damage to fire at Nagasaki. Subsequent ground survey was able to reduce the estimated figure considerably.

**2. Use of Intelligence Derived from Photo Interpretation.**—The use of intelligence derived from photo interpretation will be of great importance in planning future operations employing the atomic bomb. Physical Damage Division reports on Hiroshima and Nagasaki provide sufficient detailed information to establish the effects of atomic bombs on different types of structures, that is, the physical vulnerability of buildings to this type of bomb has been determined. Therefore, since types of buildings can be identified and areas measured by aerial photographs, damage inflicted on most buildings can be determined by the following factors:

- Construction.
- Distance from AZ or GZ.
- Relation of location to topography of area.
- Shielding effects of other buildings.
- Orientation with respect to direction of blast.
- Height of bomb burst.

**3. Vulnerability Evaluation.** In photo interpretation of the future a method must be developed for evaluating vulnerability of a target area by considering all of the foregoing factors and by taking into account all physical and economic effects to be reasonably expected from an atomic-bomb attack on the area.

## N. DETAILED PHOTO-INTERPRETATION INDUSTRIAL REPORT

**1. The Target.**—A study was made of the Akunoura Engine Works, a unit of the Mitsubishi Shipbuilding Co., as this was the only target in the city on which complete pre-attack studies had been made.

**2. The Plant.**—The plant occupied an area of approximately 1.6 million square feet. The northern boundary was 9,800 feet from GZ, the southern boundary 12,200 feet. Building area was 866,700 square feet, most of it of steel-frame construction.

**3. Pre-Attack Photo Intelligence.**—Using all available information, both photo and ground, photo interpreters prepared structural and functional analyses of the plant buildings prior to the attack.

**4. Post-Attack Photo Intelligence.**—By carefully comparing photos made before and after the attack, photo interpreters were able to outline on a plot plan of the plant all areas of visible structural and superficial damage. Findings on some 55 buildings or sections of buildings were compared with those determined by ground survey, with the following results:

Comparison of estimates

Area (1,000 square feet)		Damage (1,000 square feet)			Percentage structural damage	
		Photos		Ground		
Photos	Ground	Structural	Superficial	Structural only	Photo	Ground
788.3	866.7	72.2	60.5	136.9	9.1	15.7

### III. GENERAL INFORMATION

**1. Team Personnel.**—The following personnel of Physical Damage Division Team 2 conducted the survey in Nagasaki, Japan:  
 Maj. William V. Dragnett, QMC, Team Leader, Structural Engineer.  
 Maj. Ralph C. Fletcher, AC, Ass't. Team Leader, Architect.  
 Maj. Robert T. Marshall, SC, Electrical Engineer.  
 Maj. George P. Guill, ORD, Ordnance Officer.  
 Capt. Gerald O. Waeterling, CMP, Fire Engineer.  
 Capt. Ving L. Smith, AC, Photo Intelligence Officer.  
 Capt. Milton E. Jenkins, AC, Photo Intelligence Officer.  
 Capt. Lawrence E. Orin, CE, Structural Engineer.  
 Capt. Arne E. Fessel, AC, Mechanical Engineer.  
 Lt. Comdr. James J. Hitchcock, USNR, Language Officer.

#### 5. Analysis of Findings

*a. Classifications.*—(1) The total of photo area measurements was 91 percent of the actual total determined by ground survey.

(2) Eighty-eight percent of the buildings were correctly identified as to construction.

(3) Fire classification was correct for 94 percent of the building area. Presence of fire walls was greatly overestimated as there was not a single fire wall in the entire plant.

*b. Damage assessment.*—Structural damage was only 53 percent correctly identified. Three types of structural damage are almost impossible to detect by aerial photographs: Damage to columns sufficient to render them structurally unsound but not severe enough to cause visible sagging of roof; distortion or cutting of truss members by fragments to the extent that the truss would require repairs even though the whole truss were not distorted sufficiently to be visible on photographs; and interior damage to reinforced-concrete buildings.

*c. Functional analysis.*—A rather large proportion of the minor buildings in this plant were incorrectly identified as to function. Ground information was scarce, and in an industrial plant of this type minor buildings show few characteristics of construction which might serve as a clue to functional identification.

Lieut. William J. Walsh, USNR, Structural Engineer.  
 Lieut. Paul M. Speake, USNR, Architect.  
 Lieut. (jg) John W. Waterbury, USNR, Architect.  
 MM/C Pierre K. Domercq, Draftsman.  
 SP. (X) 3C Charles R. Frank, Draftsman.  
 Sgt. Raymond S. Waldron, Draftsman.  
 Sgt. Elio E. Ciesla, Draftsman.  
 Sgt. William V. Parsons, Clerk.  
 Y3C Clare J. Gould, Clerk.  
 Sgt. Arthur T. Hiroshima, Translator.  
 Cpl. Ray R. Orite, Translator.

**2. Photography Personnel.**—Photography was done for the team by the following Regional Headquarters personnel:

CWO Charles T. Northrop, Photography Supervisor.

PhoM1c Chester J. Hovy, Photographer.  
 Sgt. Gordon W. Blackmer, Photographer.  
 Sgt. Joseph T. Quinn, Photographer.  
 Cpl. Walter A. Krajicek, Photographer.  
 Pfc. Noel J. Redmond, Photographer.

**3. Date of Survey.**—The field work pertaining to the survey in Nagasaki was accomplished between the dates of 14 October 1945 and 18 November 1945, inclusive. These 36 days were spent in obtaining and recording the information upon which this report is based.

#### 4. Appreciation

*a. The Second Division of the United States Marine Corps, which was charged with the military government and occupation of the Nagasaki area, extended every courtesy to the team and its members. Many supplies, necessary passes, and services were made available to the team.*

*b. Fifteen members of the British Mission to Japan who were in Nagasaki for approximately 14 days assisted generously in the obtaining of the material contained in this report. Appreciation is extended to the following members of that organization for this cooperation:*

G/Capt. William N. Thomas.  
 G/Capt. Albert E. Dark.  
 G/Capt. Frederick G. S. Mitchell.  
 Col. O. L. Solandt.  
 W/Comdr. Jacob Bronowski.  
 W/Comdr. Douglas C. Burn.  
 Lt. Comdr. D. Evans.  
 Sqdn. Ldr. Robert G. Whitehead.  
 Flt. Lt. Percy A. Badland.  
 Flt. Lt. Ronald W. Bevan.  
 Flt. Lt. Henry Elder.  
 Flt. Lt. James B. Hawker.  
 Flt. Lt. R. H. Parry.  
 Flt. Lt. Francis Walley.  
 Flt. Lt. Oliver C. Young.

**5. To facilitate the study of damage analysis the structures and plants were first given tentative letters, then final numbers. Inasmuch as other investigating agencies have used the tentative letters, both are given herewith.**

Group	Tentative letter	Name	Part
1	K	Boy's Normal School	3
2		Urakami transformer station	4
3		Kindergarten	2
4	J	Mitsubishi Torpedo Works	(1) 2
5	H	Mitsubishi Turbine Component Works No. 2	2
6	F	Onoda gas works	2
7	P	Divinity School	3
8	M	Yamazato School	3
9	N	Engineering School	3
10	V	Nagasaki Commercial School	3
11		Gohoku Shrine	3
12	B	Area west of railroad and highway	(2) 2
13	L	Nagasaki Prefecture Prison	3
14	BB	School for Blind and Dumb	3
15	Q	Urakami Cathedral	3
16	W	Shiroyama School	3
17	R	Nagasaki Medical College	3
18	BBB	Chinzei School	3
19	A-1	Urakami branch Mitsubishi Hospital	3
20	S	Nagasaki University Hospital	3
21	A-1	Private Mitsubishi Boy's Industrial School	3
22	A-1	Mitsubishi Nagasaki Workers' Club	3
23		Yamaiv Shrine	(1)
24		Nagasaki Tuberculosis Clinic	(2)
25	X	Kishu Boy's High School	3
26	A	Mitsubishi Steel and Arms Plant	2
27	Y	Fuchi School	3
28	DDD	Nagasaki municipal crematory	3
29	CCC	Nagasaki Hygiene Experimental Center and Hospital for Contagious Diseases	3
30		Unidentified	(1)
31	Z	Mitsubishi Steel and Arms Casting Plant	2
32	T	Zenra School	3
33		Zenra substation	2
34		Fuchi Shrine	(1)
35	AA	Mitsubishi Woodworking Plant	2
36	C	Mitsubishi Turbine Component Works No. 1	2
37	C	Prisoner of war camp (Saiwai Machi)	3
38	CC	Inasa School	3
39		Kyushu Electric Power Plant	2
40	D	Standard-Vacuum Oil Works	2
41	E	Yachiyo Machi Gas Works	2
42	U	Nishikawa School	3
43		Hiradogoya Works, Mitsubishi Electric Co.	(2)
44	AAA	Nagasaki station and freight yard	2
45	PPP	Nagasaki station and freight yard	2
46	QQQ	Honren Temple	3
47	RRR	KoKuh Fukusoi Temple	3
48	DD	Asaki School	3
49	KK	Ice plant	2
50	HH	Mitsubishi Electric Manufacturing Co.	2
51		Takenokubo substation	2
52	JJ	Akunoura Steel Works	2
53		Mukushima substation	4
54	LL	Mitsubishi dock yard	2
55	MM	Tategami shipyard	2
56		Tategami substation	4

See footnote at end of table.

Group	Tentative letter	Name	Part
57	WW	Otao shipyard.	2
58	NN	Kosaki Point oil storage	(2)
59		Upper filtration bed.	(2)
60		Lower filtration bed.	(2)
61		Nagasaki Commercial College.	(2)
62		Kama Nagasaki Grade School.	(2)
63		Municipal Girl's School.	(2)
64		Nagasaki Middle School.	(2)
65		Iribayashi Grade School.	(2)
66		Prefectural Library.	(2)
67		Nagasaki Museum.	(2)
68		Governor's residence.	(2)
69	NNN	Katsuyama Grade School.	3
70	MMM	Nakamachi Church.	2
71	LLL	Tobacco Monopoly Agency.	3
72		Funatsu Machi branch of Mitsubishi Hospital.	3
73	JJJ	Shinkooren School.	(2)
74		City Hall.	(2)
75		Chamber of Commerce.	3
76	KKK	Municipal Girl's Commercial School.	(2)
77		Kyushu Electric Co., branch office.	(2)

Group	Tentative letter	Name	Part
78		District court and public prosecutor's office.	3
79	HHH	Regional court and public prosecutor's office.	3
80	GGG	Relief Association office.	3
81	FFF	Nagasaki prefectural office and courthouse.	3
82	ZZ	Dejima wharf.	2
83	EEE	Main post office.	3
84	YY	Consulate office.	(2)
85		Mission School.	(2)
86		Ouramachi Middle School.	2
87	XX	Mitsubishi Trading Co.	2
88	TT	Minamioura grade school.	2
89	VV	Mitsubishi Small Shipbuilding Works.	2
90	UU	Mitsubishi Small Boat Yard.	2
91	SS	Tomachi grade school.	2
92	PP	Torpedo boat manufacturing plant.	2
93	QQ	Nippon Oil Co.	2
94	RR	Powder magazine.	2

1 Completely destroyed. 2 Minor damage.

#### IV. DESCRIPTION OF NAGASAKI

##### 1. Geography and Climate

a. *Location*.—The city of Nagasaki is located on the western coast of Kyushu, the southernmost of Japan's four main islands, at latitude 32°44' N., longitude 129°52' E.

b. *Topography*.—The city lies on a narrow coastal strip encircling a long, narrow bay and extends up two valleys to the north and northeast away from the shoreline. The bay itself is about two miles long and one mile across at its greatest width, and extends roughly southwest-northeast. Its entrance is approximately 400 yards wide with depths of 12 to 15 fathoms, and is free from obstructions. This bay constitutes the river harbor, while the approaches to the bay, south and west of the entrance, make up the outer harbor, an excellent anchorage sheltered by numerous off-lying islands. The western shore of the river bay is a narrow strip of level land, much of it man made, which rises abruptly westward into hills 500 to 1,300 feet in height. North of the bay lies the flat valley of the Urakami River, averaging three-quarters of a mile in width, between the two chains of hills which encircle Nagasaki and the bay. This valley, with the western coastal strip, constitutes the industrial zone of Nagasaki, while the wider coastal strip down the eastern side of the bay and the wide Nakashima valley extending

northeast from the bay make up the main commercial and residential areas of the city. The northeastern part of the city is separated from the northern Urakami valley by a chain of hills culminating in Kompira San, 1,300 feet in height. The Nakashima valley and the eastern shore of the bay are interlaced with shallow, narrow streams which become sluggish canals when they near the bay.

c. *Climate*.—Nagasaki lies in a semitropical zone strongly influenced by the Asiatic monsoons. The cold northwesterly monsoon produces cloudy days and cold drizzles in the winter while the warm southerly monsoon in summer brings hot moist days and a great amount of rain in June and early July. Typhoons in August and September frequently strike the city as do the yearly equinoctial storms in March. Winter temperatures seldom reach the freezing point, and snow is a rarity. Summer temperatures, while not high, are accentuated by the great humidity, with the result that generally June and July days are quite uncomfortable. This discomfort is counterbalanced by the crystal-clear weather which prevails in October and early November.

d. *The prefecture*.—The seat of government of Nagasaki prefecture, one of the 49 administrative divisions of Japan corresponding roughly to our

states, is at Nagasaki. The prefectural government receives orders from the National Ministry of Home Affairs and in turn passes orders along to the municipal governments. Because it includes three groups of islands, the Goto, Iki, and Tsushima groups, and because their coasts, as well as the coast of the mainland portion of the prefecture, are deeply indented, Nagasaki prefecture has the longest coastline of any prefecture in Japan.

##### 2. History

a. *Early history*.—Prior to the twelfth century, what is now known as Nagasaki was called Tamaki-No-Tsu or Tama-No-Ura, later changed to Fukaenoura (meaning "deep bay"). In 1222 the founder of Japanese feudalism, Yoritomo, gave the area to a samurai retainer, Nagasaki Kotaro, as a fief, and the name Nagasaki was subsequently applied to the castle and the surrounding territory as was the custom in those times. Topographically, the name fits very well, its meaning being "long promontory" which quite accurately describes the area in which Nagasaki lies. The Nagasaki fief expanded during the period of Japanese civil wars in the twelfth and thirteenth centuries, but the village of Nagasaki remained small and insignificant. It served intermittently as a safe harbor and base for bands of Japanese pirates who prowled up and down the Chinese coast, reaching as far south as the Philippines and Malaya. These hordes of ruffians caused such havoc along the Chinese coast opposite Japan that at one time the Chinese Emperor was forced to evacuate the entire population of a strip 50 miles inland from the shore for a great distance along the coast.

b. With the arrival of three Portuguese ships in 1572, Nagasaki suddenly achieved a new importance. To supply these ships, the current lord of the fief, Omura, set up a settlement of shops near the present site of the prefecture offices. The Portuguese also set up shops in the town to sell their products and, with Hirado and Hakata near by, Nagasaki became one of the three foreign trade ports in Japan. Chinese vessels, particularly from Foochow, added to the stream of imported goods entering Nagasaki from 1600 on. Dutch vessels soon followed and the town rapidly took on the appearance of a foreign colony.

c. This stream of foreigners, particularly the Portuguese, inevitably brought in Christianity. Christian tenets of personal worth and eternal

salvation spread rapidly through the Japanese population, encouraged by Lord Omura, ruler of the fief. Nearly 1,000,000 converts were made. Numerous churches were built in Nagasaki, adding to the foreign appearance of the town. In 1587, the Shogunate, then ruling Japan, decided that Lord Omura of Nagasaki was too pro-foreign in attitude, and in order to remove all possible sedition during a Shogunate campaign against the Satsuma Clan farther south, the rule of the area was transferred directly to the Shogun's representative. The Portuguese and Dutch were restricted in residence to the island of Deshima on the eastern side of the bay but were permitted to move freely through the town. Antiforeign sentiment grew after the Tokugawa family took over the Shogunate in 1603, culminating in severe repression of Catholic Christianity, massacre of Christian converts, and expulsion of the Spanish and Portuguese in 1636-37. The Dutch, claiming they were not "Christians" but Protestants, were allowed to remain on Deshima and continue to trade with Japan.

d. *The Dutch on Deshima*.—For 220 years, during the Tokugawa Exclusion Policy period, the Dutch on Deshima were Japan's sole European contact with the outside world. Covertly at first, and later more openly, Japanese came from all over the country to study foreign ways, and it was through the Dutch in Nagasaki that Japan learned the rudiments of military and naval science, gunnery, shipbuilding, printing, and medicine. The great men who led Japan's reopening in the mid-nineteenth century acquired their enthusiasm for foreign ways by early contact with these Dutch. The Nagasaki Medical College owed its head start and prime position in Japanese medicine to the work of a few Dutch doctors in Deshima.

e. *History since 1859*.—In 1859, Nagasaki was one of the first three ports to be opened to trade but soon lost its monopolistic position as Yokohama and Kobe, because of their more advantageous geographical positions, forged ahead. It remained an important coaling station on the China-Yokohama run until the 1930's and was used during the 1890's as a winter base for the Czarist Russian Far Eastern Fleet. Many houses, bearing signs in both Russian and Japanese, remained standing until very recently.

f. After World War I, and particularly after 1931, the Mitsubishi shipbuilding yards dominated the life of the city. Beginning with the Manchurian

rian Incident and the subsequent China Incident in 1937, Nagasaki served Japan as a major port of embarkation and as an important center of military production.

**3. Racial Background.**—The racial background of the natives of Kyushu differs somewhat from that of the natives of Shikoku and Honshu to the northeast. There are more Malayan and Polynesian strains noticeable in Kyushu than there are farther north in the Japanese islands. The attitude of the people in Kyushu differs also from that of the people in Honshu, being more frank, encountered on Honshu, being more frank, informal, and curious. To this curiosity can be ascribed the rapid spread of foreign ideas in the Nagasaki area during the periods of Portuguese and Dutch residence.

**4. Social Conditions.**—The estimated population of Nagasaki in the summer of 1945 was 230,000 persons in a built-up area of 3.3 square miles, most of whom were dependent on various Mitsubishi industries for their livelihood. The great majority of this population lived in typical Japanese houses of mud and lath, unpainted wood and paper, crowded close together along narrow dirty streets. Their drab life was principally taken up with working long hours in the city's industrial plants or commercial shops. Their scant leisure time was usually spent in the nearest public bathhouse, in promenading along the downtown streets, or, in summer, on swimming excursions to various beaches on the islands at the entrance to the bay. Chief excitement was furnished by festivals at the Suwa Shrine, first instituted to distract the populace from the pageantry and parades of Portuguese Catholicism, by kite-flying contests, and by boat races in the bay in June.

### 5. Economic Conditions

**a. Mitsubishi industries.**—The various Mitsubishi-owned industries were the backbone of the city's economy, particularly after 1930 when the importance of the port as a coaling station for ocean liners began to decline. These industries included the Mitsubishi Nagasaki shipbuilding yards and the Mitsubishi Nagasaki ordnance works under Mitsubishi Heavy Industries Ltd., Mitsubishi Nagasaki steel works under Mitsubishi Steel Manufacturing Co., Nagasaki plant of the

Mitsubishi Electrical Manufacturing Co., and the Mitsubishi small boat yard. These plants and their subsidiary firms employed roughly two-thirds of the wage-earning population of the city during the war and, in early 1945, large numbers of students were mobilized to assist in arms production for the coming battle for the homeland.

**b. Other important industries.**—In addition to the Mitsubishi-operated industries in Nagasaki, there were the Koyagi Island shipyards of the Kawanami Industry Co. outside the entrance to the bay, and a small oxygen plant owned by the Imperial Oxygen Co. Woodworking plants and small machine shops subcontracted to Mitsubishi industries were located here and there in the Urakami Valley. Ice for fish storage was manufactured north of the shipyards on the western side of the bay.

**c. Other occupations.**—The main nonindustrial occupation of this area of many inlets, bays, and islands is now fishing. With the loss of the Mitsubishi plants in the attack of 9 August 1945, it has resumed its predominant position. Before the war, Nagasaki harbor was the base for numerous fishing boats, with or without auxiliary engines, which fished the Tsushima Strait and the west coast of Kyushu and returned to sell their large hauls in the markets at Ohato and Nakashima wharves. Farming of rice, sweetpotatoes, and vegetables in the Nagasaki region occupied a relatively small part of the city's population. In addition to the normal transportation, municipal and commercial activities of a city of this size, there was a large number of small household handicraft industries making such things as curios, crockery, clothing, and chopsticks.

### 6. Commerce

**a. Nagasaki's geographical position** opposite the mainland of Asia, near Shanghai, and the first good port in Japan for vessels coming north from South China, Southeast Asia, and the Philippines was a great aid to her volume of trade. Although her importance as a coaling station has declined recently with the increasing use of oil-burning ships in the Far East, Nagasaki is still an important commercial center and entrepot for Japan's trade with China and Southeast Asia. In 1938, the last year for which trade figures are available, the monetary value of Nagasaki's trade was as follows:

	Yen
<b>Exports:</b>	
Machinery	2,380,000
Canned sardines	840,000
Fresh fish	720,000
Other canned fish	600,000
Vegetables	350,000
Refined sugar	310,000
White potatoes	240,000
Others	440,000
<b>Imports:</b>	
Cotton goods	870,000
Bean sauce	720,000
Pine, cedar, hemlock woods	250,000
Beans	210,000
Dolomite and magnesite	150,000
Teak	140,000

**b. The city is noted for numerous commodities,** largely fish products, such as dried roe, canned sardines in tomato sauce, bonito, and dried cuttlefish. Furthermore, the pearls, tortoise shell, and damascene articles obtained in the city rank with the best in Japan. Among the sweetmeats for which Nagasaki is locally noted, the best is "katsutera," a sponge cake made from a recipe learned from the Spanish in the Sixteenth Century and so called because of the Japanization of the name "castilla."

### 7. Communications

**a. Railroads.**—As in the rest of Japan, the single-track railroad running into Nagasaki from Isahaya is built along the shoreline for most of its length because of the rugged terrain. The railroad enters the city from the north, crosses the Urakami River, and runs south to Nagasaki station. In 1930, a spur to Deshima pier was opened bringing the trains to the quayside, particularly for the fast ships to Shanghai. Railroad gage is 3 feet 6 inches. Trains operate at full capacity on the run north to Isahaya, Fukuoka, and Moji.

**b. Shipping.**—In former years, Nagasaki was a major port of call for coal in the Far East, but with the increase in the number of oil-burning ships, her importance as a fuel station declined. There was still considerable use of the port in peacetime by smaller vessels of the NYK and OSK lines running to China, Malaya, the Philippines, the Netherlands Indies, and Australia. Canadian Pacific *Empress* ships called often on their runs to China and the Philippines. A fast (22-knot) ferry service to Shanghai and Kobe was operated twice a week by the NYK Line, and

smaller ferries plied between Nagasaki and the off-lying islands to the west, the Goto, Iki, and Tsushima groups. Dock facilities are available at Deshima for large vessels of up to 8,000 tons and along Ohato for smaller ships. There was a total of 23 mooring buoys in the outer and inner harbors, 9 of which were for vessels of 12,000 tons, and launch service was available to the jetties along the eastern shore of the bay.

**c. Electrical communications.**—(1) *Telephone.*—Equipment is outmoded but kept in good repair. In Nagasaki prefecture in 1937, there were 11,176 sets in use, most of them old wall sets, but reception was often impaired or delayed by inadequate operation. Kumamoto is the central relay point for long-distance calls, as it is for telegraph facilities.

(2) *Telegraph.*—Equipment is simple and badly overworked by the great volume of traffic. Maintenance is inadequate with frequent long interruptions of service. Nagasaki is the terminus for cables from Shanghai and Formosa, now all government operated. Formerly, the Danish Great Northern Telegraph Co. operated a line to Shanghai, but lost it to the Japanese government in the 1930's.

(3) *Radio.*—The city had its own station, JOAG, broadcasting programs of the Japan Broadcasting Corp. under rigid government control. During the war, ownership of short wave receiving sets was punishable by death, and all programs were heavily loaded with propaganda for the cheap medium-wave home sets which were in wide use.

### 8. Culture

**a. Religious.**—(1) *Buddhism.*—Although Buddhism reached Japan from China in the eighth century, it was not widely disseminated in Kyushu, the people clinging instead to their ancient Shinto religion. In the sixteenth century, contemporary with the arrival of the Portuguese and their Christianity, contacts with China increased greatly, resulting in many conversions to Buddhism in Nagasaki and the surrounding area. The numerous Chinese settlers in Nagasaki built several large temples in the Chinese manner, and the prestige of the religion increased with the power of the various Chinese guilds. During the suppression of Christianity in the early seventeenth century, many Christians switched their allegiance to Buddhism which was approved by the Shogunate government for its lack of subversive tenets such as were feared from Portuguese Jesuit Catholicism.

Since that time Buddhism has flourished in the Nagasaki area, and the magnificent Chinese-style temples in the city attest to the wealth of its adherents.

(2) *Shinto*.—This is the foremost religion in Japan and was until lately the national religion, with the Imperial family as the highest priests. It has developed from primitive nature worship to an advanced state religion, glorifying the Japanese nation and death on the battlefield for the Emperor. In Nagasaki, Shinto centers around Suwa Shrine, built in the seventeenth century to distract the people from the attractions of Catholicism. Special Suwa Shrine festivals were instituted to rival and later take the place of the colorful Catholic ceremonies and parades held by the Portuguese missionaries and their converts. Shinto grew stronger under state encouragement, beginning especially with the Meiji Restoration of 1868.

(3) *Catholicism*.—After the suppression of Portuguese Catholicism and the persecution of Christians in Kyushu described above, Catholicism became a dead force in Japan. A small band of converts, however, largely concentrated in the Urakami area of Nagasaki, clung secretly to their faith for more than 200 years until freedom of religion was restored to Japan with the reopening of the country. Nagasaki has since led Japan in Catholicism and was the site of the largest cathedral in the Far East. The oldest Catholic church in Japan, built in 1868, is also located in this city. It is indeed ironic that most of the descendants of this heroic group of Japanese Christians were wiped out in the attack of 9 August 1945, which also destroyed the cathedral.

(4) *Protestantism*.—The Dutch in 1637 claimed exemption from the expulsion of Christians from Japan on the grounds that they were Protestants. They never made efforts to convert Japanese to their beliefs, fearing possible repercussions which might affect their trading privileges. Efforts to convert Japanese to Protestantism have been made since the arrival of missionaries, largely American, in the 1880's. Their work has not been particularly spectacular and was to a large degree negated by the severe thought-control policies of the Japanese government during the recent war.

b. *Education*.—(1) *The medical school*.—This college, long the foremost medical institution in Japan, was established before the re-opening of the country. Medical learning in Japan began here with the knowledge obtained from the Dutch on

Deshima. The medical school and its fine hospital, located in the Urakami valley, were built from 1923 to 1935, and the hospital buildings were among the most modern in Japan.

(2) *Schools*.—The city of Nagasaki appeared to have a large number of schools in proportion to its population. Many of the newer schools were concentrated in the Urakami valley and served as auxiliary machine shops for the industrial plants in that area following the suspension of formal education in April 1945. Schools in the city afforded education from the primary grades through commercial, normal, and industrial courses, equivalent to the second year of college in the United States.

### 9. Military Considerations

a. *Fortifications*.—There were both Army and Navy anti-aircraft positions located in the city on the Nakashima wharves and in the hills surrounding the area. Most of the armament of these positions was old and worn out. Some of the positions actually appear to have supported only dummy guns. Coast defense fortifications were reported to exist at the entrance to the harbor on the off-lying islands and in the hills on the mainland. These do not appear to have been extensive and the armament dated back to 1896.

b. *Naval activities*.—One of the two largest battleships in the Japanese Navy, the *Musashi*, was constructed at the Mitsubishi shipbuilding works. Freighters of 1,600 tons were built at the Kawanami yards at Koyagi and Fukahori, outside the entrance to the inner harbor, at the rate of about seven a month. Destroyers, a few light carriers, and one heavy carrier, the *Amagi*, were built in Nagasaki during the war. Toward the end of the war, the Otao shipyard, just inside the entrance to the inner harbor, was engaged in building five-man submarines for the defense of the homeland against the impending invasion. Repair facilities at Nagasaki, representing about 7 percent of Japan's total repair capacity, were heavily utilized all during the war.

c. *Depot and supply area*.—The city had been used as an embarkation point for Japanese military ventures in China ever since 1931. As a result, it was also used as a debarkation point for the wounded and for the white boxes containing soldier's ashes. The port area was important as a supply port and depot area during the war, particularly in the latter days when dependence on communications with Manchuria and Korea became intensified.

## V. DETERMINATION OF ZERO POINTS

1. *Location of Point of Explosion*.—The horizontal location of the explosion, or ground zero, was determined by the measurement of the angles of flash burn and shadow, and by extending lines through these angles to the point where they intersected. It was calculated that the bomb exploded above the district called Matsuyana Cho, as shown on Figure 2.

2. The heat radiated from the bomb at the time of its explosion was sufficient to cause a slight charring of exposed, unpainted wood within a radius of approximately  $1\frac{1}{4}$  miles. This charring action will be called "flash burn." There was no flash burn in areas where the wood was shielded from the bomb by screening objects. These areas will be called "shadow."

3. All suitable flash burns which were located were used in determining GZ. Because the flash causing the burns was followed by the blast of the bomb most of the objects receiving the flash burns were displaced. Stable points not affected by the blast were usually found at distances of 1 to  $1\frac{1}{2}$  miles from GZ.

4. A total of five suitable points was found. The angle from these points to the zero point was measured with an Army lensatic compass. The point selected on the object receiving the flash burn was taken at the center of the penumbra. The azimuth was measured from the point through the edge of the object casting the shadow. The purpose in selecting the center of the penumbra was to measure the angle to the center of the explosion rather than to an edge, as would be the case if the shadow were measured from the edge of the umbra.

5. The points used and results obtained are listed below:

Point No.	Distance from zero	Azimuth	Photo No.
	Miles	Degrees	
1.	1.22	186	1
2.	1.17	213	2
3.	1.03	235	
4.	1.43	355	
5.	.97	35	

6. It will be noted that the points chosen do not give an intersection of 90°. This was not possible due to the limited number of suitable

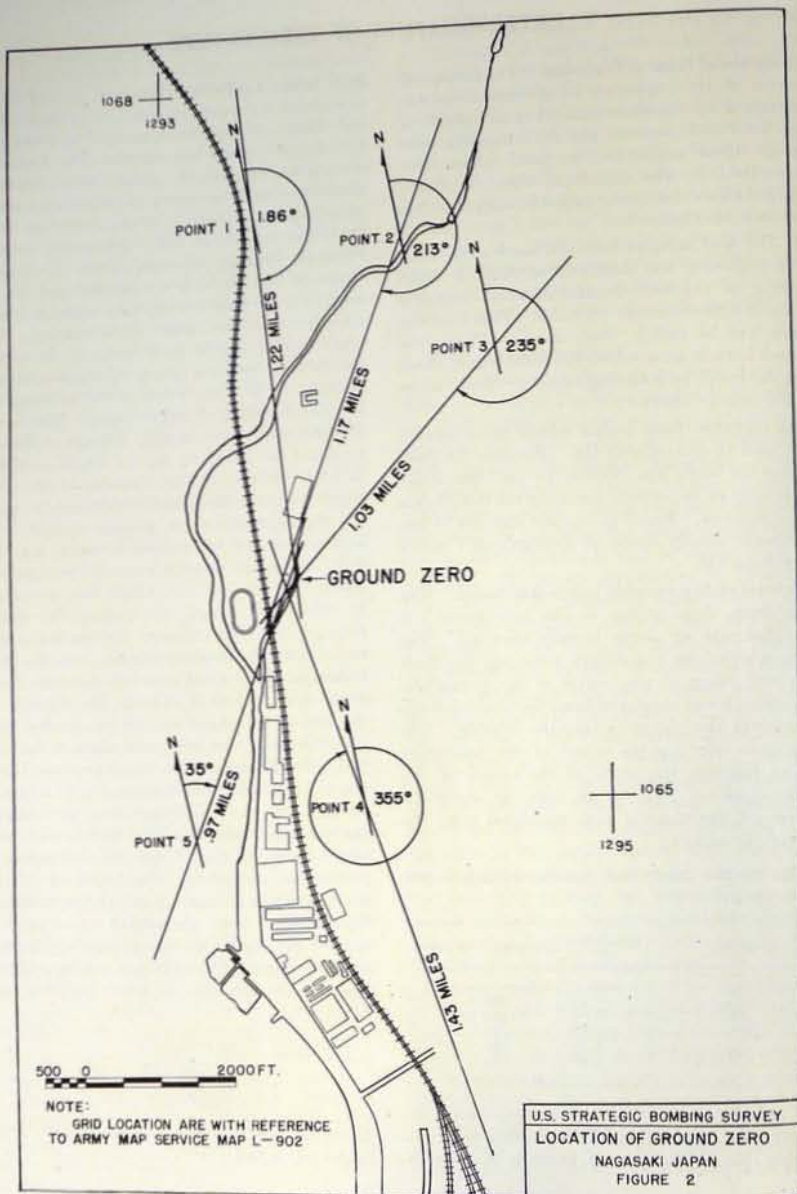
flash burns available. Points 1, 3, and 5 were considered the most reliable points used (Fig. 2 and Photo 1) for determining the location of GZ; Points 2 and 4 less reliable. The diameter of a circle including all the ground zero's found was 600 feet, a circle including the three most reliable ground zeros 80 feet. The center of this 80-foot circle was considered GZ. Before the arrival of Physical Damage Division Team 2, Japanese engineers had established a location and set up a marker at a point which they estimated to be directly below the point of detonation. They made similar use of flash burns in determining the location of their point, which was approximately 150 feet northwest of GZ as established by the Bombing Survey Team. Members of British parties investigating damage at Nagasaki accepted the Bombing Survey GZ as accurate.

7. The elevation of the explosion of the atomic bomb was determined from flash burns and shadow by the comparison of similar triangles. The average for the measurements taken was 1,700 feet. As in the measurements to determine GZ, places had to be chosen which were not affected by the blast. Also, the greater the distance between the object casting the shadow and the object burned, the more accurate were the results obtained. Two points were located where this distance was in excess of 50 feet. The distance from the top of the object casting the shadow to the object burned was measured along a horizontal line. This horizontal line was determined through the use of a level and measured with a tape. A vertical line was established from the middle of the penumbra and measured with a tape to the place where it intercepted the horizontal line previously established. The length of this horizontal line will be called  $X$  and the vertical line  $Y$ . The distance from the object upon which the shadow was cast to the zero point was determined from the map. This distance will be called  $X'$ . The altitude at which the bomb exploded will be called  $Y'$ .

Therefore

$$\frac{X}{Y} = \frac{X'}{Y'}$$

These determinations are listed below. All distances are in feet.



NOTE: Scale has been added to original of this drawing and points numbered.

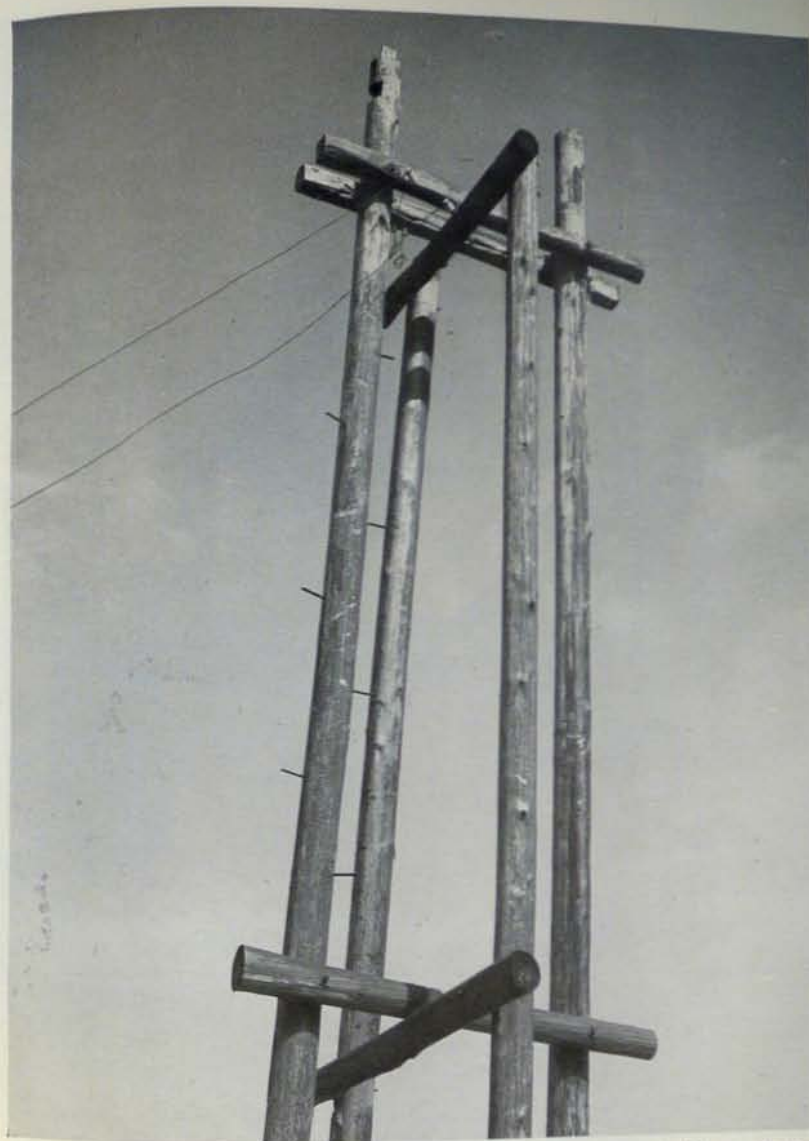


Photo 1.—6,442 feet from GZ (1.22 miles). Point 1, Azimuth 186°. AZ was above and to the right as can be seen by the uncharred faces of these poles. Note the flash "shadow" of the cross arm near the top of the poles.

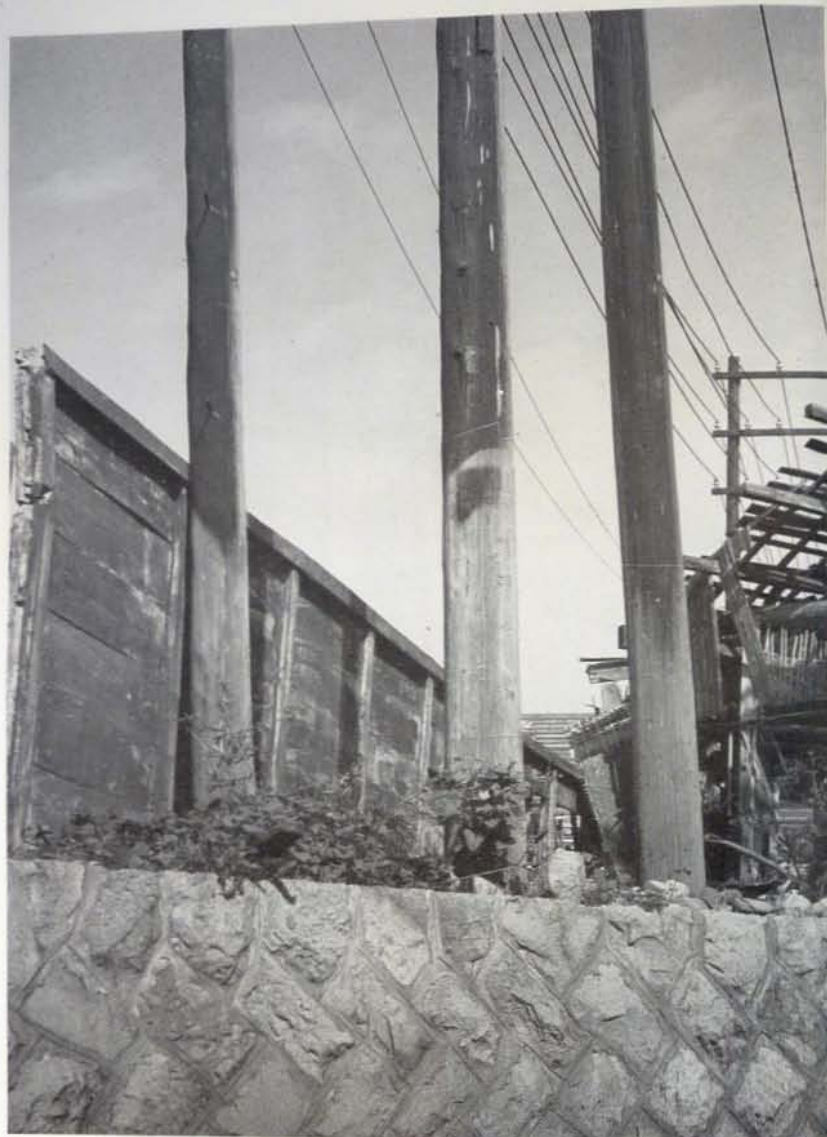


PHOTO 2.—6,178 feet from GZ (1.17 miles), Point 2. Azimuth 213°. AZ was above and to the left. The uncharred portion of the poles was protected by the fence.



PHOTO 3.—Burns on unpainted timber lintel of Japanese house approximately 6,180 feet north of GZ. Light area above burned wood shaded by eaves from heat of atomic bomb.

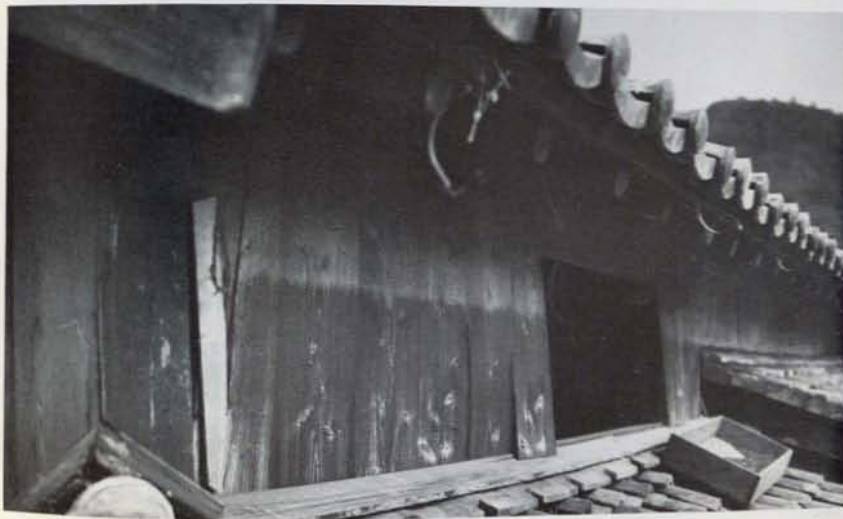


PHOTO 4.—Burns on unpainted wooden siding of Japanese house approximately 7,880 feet north of GZ. Light area above burned wood was shaded by overhanging eaves from heat of atomic bomb.



Photo 5.—4,650 feet from GZ. Flash burn on gate. AZ above and to the left.



U.S. STRATEGIC BOMBING SURVEY  
H. E. BOMB PLOT  
NAGASAKI JAPAN  
FIGURE 3



PHOTO 6.—Group 26, Building 32. Damage caused by high-explosive bomb prior to 9 August 1945.



PHOTO 7.—Group 26, Building 19. Crater of high-explosive bomb. No damage caused to building.



PHOTO 8.—Group 26, Building 23. Damage caused at base of reinforced-concrete stack by high-explosive bomb.



PHOTO 9.—Group 26, Building 16. Frag damage to steel girder and to concrete stack caused by high-explosive bomb.



PHOTO 10.—Group 26, Building 16. Damage to foot of concrete stack caused by high-explosive bomb.



PHOTO 11.—Group 26, Building 13. Frag damaged steel caused by high-explosive bomb at northwest corner of building.



PHOTO 12.—Group 20, Building 17. Damage to concrete building by high-explosive bomb prior to 9 August 1945.



PHOTO 13.—Group 20, Building 18. Crater and damaged concrete columns caused by high-explosive bomb.



PHOTO 14.—Group 20, Building 32. Damaged at south-east corner of building caused by high-explosive bomb.



PHOTO 15.—Group 26. Damage to concrete vault east of road caused by high-explosive bomb.



PHOTO 16.—Group 1, Building 7. Damage to third floor caused by high-explosive bomb. Hole of entry shown in roof slab.



PHOTO 17.—Group 1, Building 7. Damage caused to north wall by high-explosive bomb.

X	Y	X'	Y'	Photo
1.45	.40	6,180	1,660	3
1.50	.40	6,180	1,650	-----
76.70	15.00	8,660	1,690	-----
55.80	15.00	6,180	1,700	-----
1.97	.43	7,880	1,720	4
6.06	3.25	4,650	2,500	5

The last determination is not considered reliable because of the probability that the gate post was shifted by the blast. This determination was included because the flash burn shown in Photo 5 clearly shows the method used in determining the altitude of the explosion. From the determinations above it was estimated that the altitude of the explosion was approximately 1,700 feet.

**8. High-Explosive Bombs.**—Figure 3 (aerial photo) shows the high-explosive bombs which fell in the Mitsubishi Steel and Arms Plant (Group

26) and in the Nagasaki Hospital (Group 20) prior to 9 August 1945. All other groups were free of such bombs except the school directly north of the torpedo test basin (Boy's Normal School, Group 1). The photos showing this bomb are numbers 16 and 17.

**9.** The other bombs are numbered on the aerial photo and those for which ground photos were taken are listed below.

Bomb No.	Photo No.	Bomb No.	Photo No.
2-----	6	12-----	11
4-----	8	16-----	14
5-----	9 and 10	17-----	12
6-----	7	18-----	13
9-----	15		

**10.** A bomb plot was also made at the Akunoura Engine Works (Group 52) in collaboration with the Photo-Interpretation Section and is included in the Photo-Interpretation Report in this part.

## VI. PHOTO-INTERPRETATION

**1.** This report describes the photo-interpretation reports on Nagasaki and makes certain recommendations as guides for future work of this type.

**2.** Damage assessments prepared by photo interpreters after attacks with conventional high-explosive and incendiary bombs have usually been done in two sections, one covering the damage to residential, commercial, and public buildings and other giving the damage to industrial plants. Public utilities (gas, water, power plants, transformer station) were usually included with the industrial plants. Methods of preparation and presentation and the amount of detail included in these reports differed widely, but the division between residential and industrial damage has been general. The reasons for this were several. It was customary to use different tactics and weapons in attacking the two classes of targets. Estimation of the loss to the enemy in lives and units of production, the real measure of the success of an attack, required the preparation of different material from photographs of the various areas. The report on damage to residential and commercial buildings usually gave the area of damage which, with the known characteristics of the various zones of the city, was sufficient to give the number of

dwellings units destroyed and an indication of the interruption of services. From these figures the loss in man-hours which would occur before the populace could be rehoused and the normal routine of work restored could be closely estimated. Industrial reports went into much greater detail, sometimes giving the amount of structural and superficial damage to each building of a plant, together with the cause of the damage, so that the destruction of machines, stocks, and work in progress could be estimated.

**3.** The atomic bomb is, more than any other, a weapon for attacking an entire area. Within a certain radius of the point of detonation all structures above the surface of the ground will be affected to some degree. An assessment of the damage inflicted must furnish all the types of information mentioned earlier if the effect of the attack is to be fully evaluated, a monumental task due to the extent of the damage. The task was further complicated by the lack of knowledge of the effects of the bomb.

### 4. General Report on City

*a. Nature of the photo-interpretation reports prepared after the attack.*—Following the atomic bomb attack on Nagasaki two separate but complementary

tary damage assessments were prepared by photo interpreters of the Joint Target Group, Office of the Assistant Chief of Air Staff, Intelligence. The reports were prepared from four prints of small scale and fair quality taken on photo mission 3PR5M396 (13 August 1945). These prints covered the entire area of the city with only slight cloud cover and gave stereo cover of approximately 80 percent of the damaged area. The two reports were; first, an urban damage report and, second, an industrial damage report.

**(1) Urban damage.**—This report was prepared by outlining on a photo mosaic of controlled scale (1/25,000) every area of visible damage in the city. No effort was made to distinguish between the damage caused by the atomic bomb and that caused by the several high-explosive attacks which preceded the atomic bomb attack; the latter, however, were known to be slight, almost negligible in comparison with the total area of damage. The city had previously been divided into its various zones; i. e., residential, industrial, storage, business, and the like, and the built-upness (percent of roof area to total ground area) determined by visual inspection. Thus, when the total area of damage in each zone had been measured, the area of roof damage was obtained by applying the built-upness factor for that zone.

**(2) Industrial damage.**—In the preparation of this report, all known important industrial plants (and other significant installations) were outlined on photo mosaics at a scale of 1/12,000. Visible damage to buildings within these outlines was plotted on the mosaics, and the percentage of visible damage was estimated. The results obtained were arranged in tabular form, together with brief notes describing the nature and severity of the damage to each installation.

*b. Comparison of photo-interpretation damage estimate with actual damage.*—(1) *Urban damage—photo-interpretation estimate.*—The following figures were obtained from measurements made on aerial photographs.

#### Key to zone symbols

#### Residential:

- R1—Fully built-up (40 percent and over).
- R2—Moderately built-up (20–40 percent).
- R3—Sparsely built-up (5–20 percent).

#### Industrial:

- M—Manufacturing.
- S—Storage.
- T—Transportation.

Mixed:

X—50 percent industrial, 50 percent residential.  
(All areas given in 1,000 square feet.)

Zone	Ground	Percent built-up	Roof	Ground area of damage	Roof area of damage
Residential:					
R1-----	21,000	45	9,380	4,330	1,670.8
R2-----	40,300	30	12,090	14,398	3,914.0
R3-----	27,300	12	3,280	6,820	1,164.0
50 percent of X-----	850	33	283	505	176.7
Total-----	89,450		25,033	26,053	6,925.5
Industrial:					
M-----	11,700	46	5,360	5,890	2,636.5
S-----	4,300	28	1,200	1,135	115.2
T-----	1,000	9	90	990	80.0
50 percent of X-----	850	33	283	505	176.8
Total-----	17,850		6,933	8,520	3,008.5

In addition, areas indicated as firebreaks on the damage plot were as follows:

	Ground area	Roof area
Residential:		
R1-----	2,610	1,305
R2-----	1,580	527
R3-----	10	6
Industrial:		
M-----	25	15
S-----	110	28

It should be noted that, since only a portion of each zone was affected by the bomb, built-upness factors were determined for the damaged areas only, and these were used in calculating the areas of roof damage. As it was not found practical to measure the built-upness of the zones in the ground survey, the only checks on these factors were estimates made during the survey of the urban damage. These estimates proved the zoning done from aerial photographs to be remarkably accurate.

**(2) Urban damage—field estimate.**—The urban area damage survey as made in the field produced figures for the total ground area of structural and superficial damage to the urban area of the city, excluding the damage to industrial plants and those buildings picked for special study. The damage is classified as to cause; i. e., blast, fire, or a combination of the two. The figures obtained are presented for comparison with the photo-interpretation measurements.

# Ground area of damage

Cause	Structural		Superficial	
	Area in square feet	Area in square feet	Area in square feet	Area in square feet
Blast only	2,701,000	8,536,000		
Blast and fire	24,087,000			
Fire only	1,370,000			
Total	28,158,000	8,536,000		

Total area of urban damage, 36,700,000 square feet.  
Total urban area of city (excluding industry) 91,800,000 square feet.

Very close comparisons between the figures obtained by photo interpretation and those obtained by the ground survey cannot be made because of the differences in the definition of urban area. The photo interpreters excluded from urban areas all areas used for manufacturing, storage, and transportation, as well as 50 percent of the area designated as a mixture of residential and manufacturing buildings. The ground survey excluded all areas picked for special study; these included not only industrial plants but schools and hospitals as well. A reasonable figure for comparison can be obtained by taking the area of structural damage in urban areas (superficial damage to residential buildings is seldom identifiable on aerial photographs) as found by the ground survey and adding to it the ground area of industrial damage (obtained by dividing the total area of industrial building damage by the average built-upness of the industrial areas damaged). This gives a total area of damage, visible on photographs, of 33,100,000 square feet which compares quite closely with the photo-interpretation total of 34,573,000 square feet.

c. *Industrial damage.*—Estimates of visible damage to those industrial plants and other significant installations on which unclouded stereo cover was available are presented together with actual figures for comparison.

d. *Characteristics of damage caused by atomic bomb.*—An attempt was made to describe the particular effects of the atomic bomb on various types of buildings within the damage area, using information derived from aerial photographs. The conclusions drawn were as follows:

(1) *Residential buildings.*—Damage to residential-type buildings consisted of an area of complete destruction, bordered by an area of lesser damage in which buildings nearest GZ showed

some distortion, indicating that complete rebuilding or extensive repairs would be necessary before they were again habitable; and buildings farthest away from GZ showed discoloration of the roofs, indicating disturbance of roofing tiles. It was concluded from the uniform gray appearance of the area of complete destruction that this damage was due almost entirely to a combination of blast and fire; this opinion was substantiated to some degree by the fact that great fires were known to have burned in the city for several hours after the attack. The appearance of the debris and ash which remained in the area of destruction differed in only one particular from that of an area devastated in an ordinary incendiary attack—the pattern of the streets and even the outlines of the burned buildings are usually discernible after an incendiary attack, but here not only the buildings but almost all the streets had disappeared. This led to the conclusion that blast had so shattered the buildings as to distribute the debris over the entire area; this, when burned, left a uniform residue of ashes which obliterated the pattern of streets and buildings.

(2) *Area of lesser damage.*—The area of lesser damage which bordered the destroyed area differed in no respect from the ring of lesser damage which, on a much smaller scale, borders the area of complete demolition resulting from the explosion of a heavy high-explosive bomb among residential-type buildings. This damage was, therefore, attributed to blast alone.

(3) *Industrial buildings.*—Industrial buildings, framed in either wood or steel, with roofs and walls of either light corrugated asbestos or metal sheeting, were greatly distorted by the blast of the bomb, and in some cases collapsed entirely. Roof stripping within the area of heavy damage was almost complete, and partial stripping was seen at great distances from GZ. In the Mitsubishi Steel and Arms Works and the other plants in the immediate vicinity, many of the buildings showed darkened interiors which, with the distortion of members by fire, visible in a few cases, and the disappearance of all combustible buildings, was thought to indicate fire in most of the buildings.

(4) *Reinforced-concrete stressed-skin buildings.*—Structures of this type, of which there were very few, did not show any characteristic reaction to the bomb. Approximately half of the building area collapsed completely; the other half survived without visible distortion.

JTG designation	Name	Ground survey		Damage	
		Photo-interpretation estimate		Actual (percent)	
1. Mitsubishi-Urakami Ordnance Plant	Ohashi Works of Mitsubishi Torpedo Works	No stereo cover		90	
2. Unidentified industry	Ohashi Works of Mitsubishi Shipbuilding Works	do.		80	
3. Urakami Gas Works	Ohashi plant of Kyushu Gas Co.	do.		60	
4. Barracks	Nagasaki prefecture prison	Not covered		(1)	
5. Prison	Miscellaneous small plants	100 percent		100	
6. Unidentified industry	Matsuyama Iron Works and other small plants	do.		100	
7. Several small unidentified factories	Nagasaki Medical College hospital and private Mitsubishi boys industrial school	do.		100	
8. Medical school and hospital	Nagasaki Medical School, College and School of Pharmacy	Partially obscured by clouds		60	
9. Probable barracks or school	Mitsubishi Steel Works or Mitsubishi Ordnance Works, Sawai Machine Works of Mitsubishi Shipbuilding Works prisoner of war camp	do.		95	
10. Mitsubishi Steel and Arms Works	Mitsubishi Steel Works	97 percent		95	
11. Casting plant of Mitsubishi Steel and Arms Works	Mitsubishi Steel Works	100 percent		100	
12. Mitsubishi woodworking plant	Mitsubishi woodworking plant	do.		100	
13. Steam power plant	Kyushu Electric Power Co. generating plant	do.		100	
14. Unidentified small industry	Miscellaneous small industry	do.		100	
15. Unidentified small industry	Ice plant	do.		(1)	
16. Hyashi Commercial Co. engine works	Nagasaki station and freight yard	90 percent		100	
17. Nagasaki station and freight yard	Kyushu Gas Works, Nagasaki and Dejima	85 percent		75	
18. Kyushu Gas Works, Nagasaki and Dejima	Wharves and rail yards	15 percent		10	
19. Wharves and railroad yards	Mitsubishi Electric Manufacturing Co.	5 percent		5	
20. Mitsubishi Electric Manufacturing Co.	Akunoura Engine Works	50 percent		55	
21. Akunoura Engine Works	Mitsubishi dockyard and workers' homes	3 percent		3	
22. Mitsubishi dockyard	Tategami shipyard	0.5 percent		0	
23. Tategami shipyard	Mitsubishi Trading Co.	0		0	
24. Small industrial plant	Kozaki Point oil storage	0		0	
25A. Kozaki Point oil storage	do.	0		0	
25B. Kozaki Point oil storage	do.	0		0	
25C. Kozaki Point oil storage	Coal yard	0		2	
26. New shipyard	Part of Mitsubishi small boat building works	(1)		0	
27. Small industrial plant		(1)		5	
28. Small boat yard	Torpedo boat works	(1)		(1)	
29. Barracks and storage		(1)		(1)	
30. Small boat yards		(1)		(1)	
31. Unidentified industry and storage		(1)		(1)	
32. Mogami Point oil storage		(1)		(1)	
33. Military barracks and storehouses		(1)		(1)	
34. Kamigo Reservoir		(1)		(1)	
35. Water filtration plant		(1)		(1)	
36. Nishiyama reservoirs and filtration beds		(1)		(1)	
37. Ozakura reservoir and filtration beds		(1)		(1)	

(1) Not examined.

The close check between the figures obtained from photo-interpretation and those gathered in the ground survey probably presents a better picture of the over-all accuracy of damage assessment from photos than that obtained from a comparison of the urban damage figures. The installations studied were scattered throughout the entire city and contain examples of every type of Japanese construction.

(5) *Reinforced-concrete buildings.*—Reinforced-concrete, earthquake-resistant buildings showed no visible evidence of structural damage. The buildings inspected were those designated as being of reinforced-concrete by JTG's structural analysts in their pre-attack inspection of the city. One of the buildings so designated disappeared during

the attack, but its location was so distant (9,500 feet) from GZ that it appears to have been incorrectly identified. The edges of some of the reinforced-concrete buildings were visibly irregular, but this was thought to indicate damage to parapet walls or similar construction, which did not necessarily indicate structural damage. No

instance of actual collapse or serious sagging was detected.

*e. Errors in conclusions.*—Examination of the damage by field teams revealed certain errors in photo-interpretation conclusions. Since detailed descriptions of the damage are given in other parts of this report only enough material will be presented here to illustrate the features with which the photo-interpreter is concerned.

(1) *Residential buildings.*—The area in which residential-type buildings were destroyed had been quite clearly defined by the photographs, as had the rim of lesser damage which surrounded it. Buildings of this type at GZ and for approximately 4,000 feet around it were completely demolished by the blast of the bomb, the resulting debris covering almost the entire area, masking such details as streets and buildings. Nearly all residential buildings within 8,000 feet of GZ had collapsed, the completeness of their destruction decreasing gradually until at the outer edge of this area the damage could not be distinguished from that caused by a high wind. Blast pressure against walls and roof led to deflection of failure of the frame sufficient to cause collapse. The blast wave acted upon the building as a whole, producing an effect distinctly different from the localized blast of conventional high-explosive bombs.

(2) *Area of lesser damage.*—Beyond the boundaries of the area of collapse many buildings were still standing but so seriously damaged as to require complete rebuilding before they would be habitable. In the vast majority of these cases, the outline of the building was altered to the extent that could be designated as damaged from aerial photographs even though the degree of damage could not be specified. The same generalization can be applied to those buildings still farther away, which suffered nothing more than widespread roof damage; this damage could be seen but not accurately described.

(3) *Fire in area of blast damage.*—Many fires burned within the area of blast damage, spreading, in some cases, beyond the limits of severe blast effects. These fires did not, however, spread over the entire area of damage nor did they burn in any well-defined pattern. A careful examination of the first satisfactory photographs taken after the attack (3PR5M396) and of later and larger-scale photographs did not reveal any satisfactory means of distinguishing those areas devastated by blast and fire from those affected by blast

alone. In the areas where the fires burned beyond the area of severe blast damage, the absence of houses severely damaged but not collapsed around the edge of such areas is useful as an indication of the cause of damage. This, however, is a special case and is of no great value in determining cause of damage over the entire area.

(4) *Industrial buildings.*—By far the greater part of the damage inflicted on wood- or steel-frame industrial buildings was caused by the blast of the bomb. The pressure wave, acting on the entire area of the walls and roofs exposed to the blast, brought about a type of damage which is peculiar to the explosion of atomic bombs. Entire buildings or very large portions of buildings were distorted as units by the pressure exerted against large areas of the building surfaces, in contrast to the localized effect of even the largest of conventional high-explosive bombs. Light corrugated sheeting used on roofs and sidewalls was stripped off and scattered about.

(a) Distortion of large sections of framing wrought considerable havoc within the buildings. Many traveling cranes fell from their rails. Overhead shafts furnishing power to machine tools through belt drives were shifted and sometimes fell. Machine tools were overturned and damaged by the falling shafts or by the belts which had driven them. In 1 two-story, steel-frame building the concrete second floor collapsed, effectively wrecking all the tools on the floor below. With these exceptions, however, there were very few cases where distortion, without collapse, of a frame building damaged the tools inside. Photographs reveal the damage well enough so that incidents where collapse or distortion have been severe enough to cause damage to the contents can be distinguished from those where this did not occur.

(b) Roofing sheets falling on machine tools were not heavy enough to damage other than the lightest tools. Asbestos roofing generally broke into small pieces which could do very little damage. The area of roof stripping was so large, however, that little effort was made to put temporary covers over the tools, and a great deal of damage was caused by exposure to the weather.

(c) Those portions of the stressed-skin, reinforced-concrete buildings which collapsed either totally or heavily damaged everything on the floor in these areas. The remainder of the buildings, though cracked and distorted, continued to

furnish some measure of protection to their contents.

(d) Numerous fires burned in the industrial plants, but the majority of these were confined to combustible buildings. Such buildings were generally of minor importance. Although fires did make a contribution to the total damage suffered by the industrial plants, it was not a major factor in their destruction.

(5) *Reinforced-concrete buildings.*—The heavy reinforced-concrete buildings within the damage area should be divided into two classes in considering the effect of the bomb: earthquake-resistant buildings, characterized by flat roofs; and buildings having peaked roofs supported by timber or steel trusses.

(a) None of the earthquake-resistant buildings collapsed when the bomb exploded. Although one wing of the Shiroyama School had collapsed by the time the ground survey team reached the city, photographs prove that this wing was still standing almost a month after the attack. No information was available as to whether the building collapsed of itself or was demolished by the Japanese. Most of these buildings were damaged to some extent, the exceptions being the extremely heavy buildings of the University hospital. Walls, columns, beams, and roofs were cracked, the roofs bowing upward or downward under the stress caused by the blast and the deflection of the walls. In a few cases small sections of the roof fell in. The resulting holes and the bowing of the roofs were the only evidences of structural damage to buildings of this type which were visible on aerial photographs. The evidence was obscure and was overlooked in the assessment of the damage at Nagasaki, but careful study would have revealed it if its significance had been understood. Holes in the roof are self-evident; bowing of the roof was shown by slight changes in the tone of the roof or by water collecting in the depressions after a rain, which appeared as dark patches on the light-colored roof surfaces. Although the earthquake-resistant buildings were also fire-resistant, most of them had finish flooring and false ceilings of wood. These usually burned, making the buildings unusable even though they were not structurally damaged. There was no case in which such a fire caused any external damage which would be visible on photographs. Parapet walls on the flat-roofed buildings were often distorted sufficiently to give the building an irregular outline when viewed on aerial photo-

graphs. This irregularity was noted but did not actually furnish a clue to the real extent of damage to the building.

(b) Reinforced-concrete buildings having roofs supported by steel or timber trusses, even though they may have been equally as heavy as the earthquake-resistant buildings in all other features of their construction, did not withstand the blast as well as did the flat-roofed buildings. The roofs of these buildings were not so strong as flat roofs, nor did they contribute as much to the strength of the structure. As a consequence, roof collapse resulted in severe damage to the top story of the building. This damage was evident in aerial photographs.

**5. Conclusions.**—On the basis of the information gathered by the ground survey and presented in this report certain conclusions have been drawn and are presented herewith.

*a. Residential buildings.*—The area in which residential-type buildings of Japanese construction are destroyed by an atomic bomb can be accurately defined from aerial photographs. The buildings surrounding this area which have been seriously damaged without collapsing can almost always be detected, but the degree of damage cannot be accurately defined. This fact is also true of the buildings which are only superficially damaged. The same condition existed in European residential buildings damaged by high-explosive bombs, although the proportion of damaged buildings to destroyed buildings was much lower among Japanese houses attacked by the atomic bomb than among European houses damaged by high-explosive bombs. It seems reasonable to assume that a bomb of the type used at Nagasaki if used against either European or American urban residential areas of brick row housing would, besides destroying a large number of houses, render uninhabitable several times that number. A considerable portion of these, perhaps 25 percent, would be damaged beyond repair and would have to be cleared. It seems likely that the buildings requiring demolition would be located near enough to the point of detonation to have suffered structural roof damage from an air burst; if this were true, and known to be true, such buildings could be detected on aerial photographs. This interpretation, however, should not be attempted until more is known about the effects of the bomb.

(1) The sturdier construction of European and

American houses, as contrasted with those encountered in Japan, would result in a great number of buildings having roofs damaged and windows and interior walls blown out, so that they would not be habitable without repairs even though they were not destroyed. It is not likely that the extent of this damage could be determined from aerial photographs; in many cases the damage would not even be visible.

(2) The cause or causes of damage in the area in which Japanese houses were completely demolished could not be identified on aerial photographs of the scale and quality generally obtained under wartime conditions. This would probably be true of an attack on a European or American city. Fires which spread beyond the area of heavy blast damage at Nagasaki might have been detected if great care had been exercised, but it would have been difficult. In European and American cities fires spreading beyond the area in which all walls had been blown down would leave the gutted buildings with walls standing which always characterize such fires.

*b. Industrial buildings.*—Frame industrial buildings of steel or timber are constructed along somewhat similar lines in almost all countries, although weight and strength of construction may differ in some degree. It is to be expected that all such buildings will behave similarly under atomic bomb attack according to their strength. Both the extent and severity of damage to these buildings can be assessed within reasonable limits of accuracy from aerial photographs. Photo interpreters trained to distinguish between the effects of fire and blast should detect the presence of fire if it occurred. Production loss estimates based on photo interpretations assume a certain ratio between the percentage of structural damage suffered by a building and the percentage of its contents which are damaged or destroyed. This ratio has been determined for damage caused by high-explosive bombs, but the same ratio does not apply when the damage is caused by an atomic bomb. It should not be assumed that the contents of a structurally damaged building are themselves damaged unless it can be seen that the building has collapsed or been so distorted as to damage the tools near one wall, or that a floor of the building has fallen. It is possible that the contents may be susceptible to damage by exposure to the weather. If this is known, special note should be taken of it. All post-attack sorties should be examined for

evidence of emergency coverings over exposed machinery or of removal of building contents.

*c. Reinforced-concrete buildings.*—(1) Serious structural damage to reinforced-concrete buildings having steel or timber roof trusses will probably be visible on aerial photographs and should offer no problem to the interpreter. Earthquake-resistant buildings, however, show little evidence of damage unless it is serious enough to cause collapse. Care should be used in examining these structures for damage.

(2) Some idea of the damage suffered by the interiors of reinforced-concrete buildings might be gained from their proximity to the point of detonation, but so many factors would affect this that any estimate of this damage would be of little value.

*d. Outstanding error in damage assessments.*—The outstanding error made in the damage assessments on Nagasaki was the tendency to attribute too much of the damage to fire. Although changes in the construction of atomic bombs or decrease in the height of detonation may alter entirely the fire-producing characteristics of the bombs, this should not be assumed until it has been proved. Only experienced interpreters should attempt to identify the causes of the damage, and they should be very cautious in making their decisions.

*e. Special type of photo interpretations unnecessary.*—It is not believed that any special type of photo interpretation is necessary for the assessment of atomic bomb damage. The bomb causes damage which differs in some characteristics from that which results from high-explosive and incendiary bomb attacks, but with these characteristics in mind the interpreter should have no trouble in furnishing all the information necessary to evaluate the results. Urban and industrial assessments such as have been described will supply enough information to give an excellent picture of the over-all damage. Detailed production-loss assessments listing the severity and causes of damage in industrial plants could be prepared if plants of special interest are located in the damage area.

*f. Use of intelligence derived from photo interpretation.*—It is believed that the use of intelligence derived from photo interpretation will be of the greatest importance in the planning of future operations employing the atomic bomb. The physical damage reports on Nagasaki and Hiroshima will furnish sufficient information to determine the

effect of atomic bombs on various types of structures; that is, the physical vulnerability of buildings of this type of bomb has been established. The building types can usually be identified from aerial photographs and their areas measured. This has been the conventional procedure in making vulnerability studies for area attacks with incendiary or high-explosive weapons or both. The factors considered in these studies, however, are based on the assumption that there will be a fairly uniform distribution of individual bombs within the area attacked. Each bomb would affect only a few structures if, indeed, it affected more than one, so that the buildings could be considered almost as individual cases or as parts of small groups. Now the attacks must be planned for a single weapon which will affect a large area. The damage inflicted on buildings will depend on their construction, distance from the point of detonation, the relation of their location to the topography of the area, the shielding effect of other buildings, the orientation of the building with respect to the direction of the blast, and the height at which the bomb is exploded. All of these factors can be determined for any suggested point of detonation

by the use of aerial photographs. In addition, the effect on communications and utilities within the target area can be estimated. A method must be developed for evaluating the vulnerability of a target area, taking into account all physical and economic effects to be expected from an attack on the area directed at any of several aiming points. If some such method is used, it should be remembered that area vulnerability studies require considerable time for their preparation due to the amount of detailed work involved. If, as has been so frequently predicted, any future war which may be fought develops at a rate considerably greater than that of any previous conflict, there will be no time for detailed studies. Only a continuous program of photo-interpretation development and study which could prepare studies in advance of the time when they may be needed could supply the necessary information in time. This information must be available for attacks of maximum efficiency. It is, therefore, recommended that photo interpreters be trained for this type of work and that such intelligence material as may be needed be prepared and kept continuously up to date.

## VII. DETAILED PHOTO-INTERPRETATION INDUSTRIAL REPORT

**1. Scope.**—This section describes the reports prepared on a target before and after an attack or series of attacks, comparing a set of these reports with the correct facts, and presents some conclusions and recommendations based on the comparisons.

**2. Description of Target Selected for Study and Reasons Therefor.**—The Akunoura Engine Works, a unit of the Mitsubishi Shipbuilding Co., was selected for study as this was the only target in the city on which complete pre-attack studies had been made. The works occupied an area of approximately 1.6 million square feet extending along the west shore of the bay. The northern boundary of the plant was 9,800 feet from GZ, the southern boundary 12,200 feet. The plant had a total building area of 866,700 square feet, most of it of steel-frame construction. It was an important producer of engines, propellers, and propulsion gear for ships, as well as bomb cases, parts for torpedoes, and midget submarines.

**3. Nature of Photo-Intelligence Reports Prepared Before Attack.**—Photo interpreters, using all available information from ground sources as well as that derived from photographs, prepared functional and structural analyses of the plant as part of the pre-attack study. The functional analysis listed, as far as was known, the use made of each building or portion of a building. The structural analysis described the construction of each building and gave its area. The information contained in these two reports was sufficient to serve as a basis for aiming point selections and for recommendations of size, type, fuzing, and total tonnage of high-explosive and incendiary bombs to be used in attacking the plant.

**4. Nature of Photo-Interpretation Reports Prepared After Attack.**—By carefully comparing photos made before and after the attack, photo interpreters were able to outline on a plot plan of the plant, all areas of visible structural and superficial damage. Although bombs are shown

on the accompanying damage plan which was prepared from photographs (Fig. 4), they were plotted during the ground survey and are shown only to illustrate their relation to the visible damage.

#### 5. Tabulation of Photo-Interpretation Reports Versus Actual Findings

a. A complete report will be found under Group 52 in Part 2 of this report. The findings, together with a comparison of the functional analysis prepared by the photo interpreters and the ground survey, are given here, as is a comparison of the building areas and areas of damage.

b. Some difference will be noted between the total area given here and that given in Part 2.

d. Tabulation of areas in 1,000 square feet

Building	Sub.	Area		Damage			Percent structural damage	
		Photos	Ground	Photos		Ground	Photos	Ground
				Structural	Superficial	Structural only		
1	a	3.6	2.8					
	b	13.6	12.2					
	c	6.0	8.1			1.3		16.8
Total		23.2	23.1			1.3		5.6
2	a	12.6	13.0		6.9			
	b	4.2	(7)					
	c	4.2	4.3					
	d	2.8	2.5					
	e		1.0					
Total		23.8	20.8		6.9			
3		9.0	7.3					
4		10.2	14.0					
5	a	13.2	19.2		8.6			
	b	2.2	4.8					
Total		15.4	24.0		8.6			
6		9.8	10.9					
6A			1.4					
7		4.0	5.9					
8	a	8.4	9.2		8.4			
	b	10.2	10.8		10.2			
	c	3.0	4.0					
Total		21.6	24.0		18.6			
9		9.0	9.2		8.4			
10	a	4.5	6.4		1.9			
	b	16.8	17.4					
Total		21.3	23.8		1.9			

(7) Razed before attack.

Buildings were included in the photo-interpretation survey which were not included in the structural survey. This was due to the inclusion in the photo-interpretation report of certain buildings used jointly by the engine works and the electric manufacturing company.

c. Figures 4 and 5 show the fire classification of the various buildings and the damage suffered by each. The highest combustibility value represented by each building's construction has been given; this eliminates, as far as possible, mixed classifications and conforms to usual photo-interpretation practice. Buildings shown without fire classification on the aerial survey plan were erected after the combustibility study had been completed.

d. Tabulation of areas in 1,000 square feet—Continued

Building	Sub.	Area		Damage			Percent structural damage	
		Photos	Ground	Photos		Ground	Photos	Ground
				Structural	Superficial	Structural only		
11		4.2	(7)	4.2			100.0	100.0
12	a	78.3	82.4					
	b	21.6	22.1					
	c	32.2	41.2			3.6		
	d	45.6	41.6					8.7
	e	81.0	92.7	19.2	25.8	23.7	23.7	25.6
	f	3.6	5.7			2.2		38.6
	g	9.0	5.6	9.0		5.6	100.0	100.0
	h	101.4	101.8		70.1	8.3		8.2
	i	3.0	3.7					
	j	4.0	4.4					
	k	5.0	5.7					
Total		384.7	406.9	28.2	95.9	43.4	7.3	10.6
13	a	5.5	4.9			2.9		59.2
14	b	3.0	2.4	3.0		2.4	100.0	100.0
Total		8.5	7.3	3.0		5.3	35.3	72.6
15	a	53.9	62.1	7.4	41.9	13.0	13.7	20.9
	b	27.6	30.4	3.1	24.5	5.8	11.2	19.1
	c	17.2	21.0		17.2	6.3		30.0
	d	16.5	22.4	2.2	14.3	12.6	13.3	56.2
	e	5.8	1.7					
	f	2.1	4.7					
Total		123.1	142.3	12.7	97.9	37.7	10.3	26.5
16	a	9.1	8.3	0.8	8.3	1.8		21.7
	b	14.0	12.8		14.0			
Total		23.1	21.1	.8	22.3	1.8	3.5	8.5
17	a	15.2	21.2	11.4		21.2	73.0	100.0
	b	3.5	2.6	3.5		2.6	100.0	100.0
	c	8.4	7.6	8.4		7.6	100.0	100.0
	d	22.4	32.9			6.5		19.7
Total		49.5	64.3	23.3		37.9	47.1	58.9
18	a	10.5	9.6					
	b	3.0	2.7					
Total		13.5	12.3					
18 B			3.8					
18 C			.8					
19	a	7.2	7.7					
	b	4.2	4.5					
Total		11.4	12.2					
19 A		(9)	3.1	(9)	(9)	3.1	100.0	100.0
19 B		(9)	3.0	(9)	(9)	3.0	100.0	100.0
19 C		(9)	2.0	(9)	(9)	2.0	100.0	100.0
19 D		(9)	1.4	(9)	(9)	1.4	100.0	100.0
20		9.6	8.2					
22		7.8	7.7					
23		5.6	3.9					
Total		788.3	866.7	72.2	260.5	136.9	9.1	13.8

(9) Cleared.  
(9) Hammerhead crane.  
(9) Not measured.

e. Building construction and functions

Building	Sub.	Construction		Function	
		Photograph	Ground	Photograph	Ground
1	a1	Steel frame; C-I roof; brick panel walls.	Brick; steel truss.	Power house	Switch room.
	a2	do.	Steel.	do.	Do.
	b1 and 3	do.	Brick; wood, truss.	do.	Control room.
	b2 and 4	do.	do.	do.	Turbine room.
	c1 and 2	do.	Steel.	do.	Boiler room.
2	a1	Load-bearing walls with heavy wood trusses.	Wood columns and truss; brick wall panels.	Experimental tanks.	Storage.
	a2 and c1	do.	Steel columns; wood truss; brick wall.	do.	Welding.
	a3 and c2	do.	Steel columns; wood truss; wood wall panels.	do.	Do.
	a4	do.	Steel columns; wood truss; brick and wood wall panels.	do.	Coppersmith's shop.
	d	do.	Brick load-bearing walls; wood truss.	do.	Storage.
3		Steel frame.	Reinforced concrete; steel truss.	Hospital	Hospital.
4		do.	Brick walls; steel truss.	do.	Do.
5	a	Steel frame; C-I or corrugated-asbestos roofing.	Steel frame; C-I roofing.	Heavy machine shop.	Storage.
6	b	do.	Wood frame; C-I roofing.	do.	Do.
6A		Wood frame.	Wood frame.	Machine shop.	Do.
7		Not given.	do.	Unidentified.	Do.
8	a	Wood frame.	do.	do.	Do.
	b	Steel frame.	Steel frame.	Possible machine shop.	Brass foundry.
	c	do.	do.	do.	Foundry and tool shops.
	d	Reinforced concrete.	Reinforced concrete.	Laboratory	Machine shop and offices.
9	a and b	Steel frame.	Steel frame.	Machine shop.	Forge shop.
10	a1	Load-bearing walls; wood floors and roof.	do.	Pattern shop.	Pattern storage.
	a2	do.	Wood frame.	do.	Do.
	b1	do.	Brick load-bearing walls; wood truss.	Copper working shop.	Pattern shop.
	b2	do.	Brick load-bearing walls; steel truss.	do.	Do.
11		Load-bearing walls; wood roof.	Destroyed and cleared.	Pattern storage.	Coke storage.
12	a1, a2, and a3	Steel frame; masonry end walls and curtain walls.	Steel frame; metal walls.	Electric shop.	Erecting shop.
	a4, a5, and a6	do.	do.	Erecting shop.	Machine shop.
	b	do.	Reinforced-concrete walls and columns; steel truss.	Copper working shop.	Shipfitters' shop (welding).
	c1 through c5	do.	Metal walls; steel frame.	Forge shop.	Coppersmith's shop.
	c6 and c7	do.	do.	do.	Foundry.
	d1, d2, and d3	do.	do.	Machine shop.	Machine shop.
	e1, e2, e3, f, g1, g2, g3, and g4	do.	do.	Foundry.	Foundry.
	h1 and h2	do.	do.	Erecting shop.	Erecting shop.
	h3, h4, and h5	do.	do.	Machine shop.	Machine shop.
	j, k, and m	do.	do.	Unidentified.	Office and storage.
14	a and b	Reinforced concrete.	Reinforced concrete.	Cafeteria.	Cafeteria and offices.
15	a through f	Steel frame; masonry end walls.	Steel frame; metal walls.	Boiler shop.	Boiler shop.
16	a and b	Steel frame; wood floors.	Steel frame; wood floors.	Storage.	Storage.
17	a1	Not given.	Reinforced concrete.	Unidentified.	Offices.
	a2	Steel frame.	Reinforced concrete walls and floors; wood roof.	Storage.	Kitchens.
	b	do.	Brick walls; wood roof.	do.	Storage.
	c	do.	do.	do.	Do.
	d	Reinforced concrete.	Reinforced concrete.	Offices.	Offices.

e. Building construction and functions—Continued

Building	Sub.	Construction		Function	
		Photograph	Ground	Photograph	Ground
18	a and b	Reinforced concrete.	Reinforced concrete.	Offices.	Offices.
18 B		Not given.	do.	Unidentified.	Do.
18 C		do.	Brick walls; wood trusses.	do.	Do.
19	a and b	Reinforced concrete.	Reinforced concrete.	Possible laboratory.	Not in use.
20		do.	do.	Offices.	Offices.
22		do.	do.	Storage.	Do.
23		Steel frame.	Wood frame.	Testing laboratory.	Storage.

6. Analysis of Findings

a. Although, for some buildings, discrepancies were found between the areas measured on photos and the areas measured on the ground, the total of the photo measurements was 91 percent of the actual total. Of this area, 88 percent had been correctly identified structurally. Fire classification was correct for 94 percent of the building area, but the presence or supposed presence of fire walls had been greatly overinterpreted. There was not one fire wall in the entire plant.

b. Rapid clearance and repair of the areas of superficial damage rendered useless any attempt to measure this damage, but comparative figures for structural damage show that only 53 percent of the damage had been correctly identified. Virtually all of the damage visible from the air had been located, but a very large part of the structural damage could never have been located on vertical photographs of the scale generally obtained under wartime conditions, regardless of their quality. This damage was of three types: damage to columns sufficient to render them structurally unsound but not severe enough to cause any visible sagging of the roof; distortion or cutting of truss members by fragments to the extent that the truss required repairs even though the whole truss was not distorted enough to be visible on photographs; and interior damage to reinforced-concrete buildings.

c. A rather large proportion of the minor buildings in the plant had been incorrectly identified in the functional analysis. This was not due to erroneous interpretation of the photographs, but to the paucity of ground information. In an industrial plant of this type the buildings show few characteristics of construction which might serve as a clue to functional identification and the interpreter is, therefore, almost entirely dependent

on ground information. The chief source of information in this case was a very old insurance plan, and changes in the plant after the date of the plan could not be detected on photographs.

7. Remarks and Recommendations

a. No changes in interpretation techniques are suggested by the findings in this survey. Although general statements cannot be made on the basis of evidence found in one plant, it is nevertheless clear that a large part of the structural damage to a plant will not be visible on vertical photographs when buildings of the type under discussion are attacked by bombs the same or similar to those used in this case. Where the same conditions do not prevail—different types of buildings and bombs—an entirely different proportion of the damage will be visible. If sufficient examples are studied, values for this proportion will be obtained which will serve as guides for those evaluating damage reported by photo interpreters.

b. It is recommended that an instrument be developed for making accurate measurements of buildings while viewing them on stereoscopic photographs. The instrument should be capable of measuring lines several inches in length. Such an instrument would make measurements possible which would be as accurate as the scale and distortion of the photographs would permit.

c. Although no errors of great consequence were found in either the structural or functional analysis, more detailed information on the types of construction common to the area, together with more recent information on building occupancies, would have reduced to a minimum such errors as were made. This information can be obtained only from ground intelligence sources, and efforts should be made to assure that those agencies obtain and transmit the necessary information to the photo interpreters.

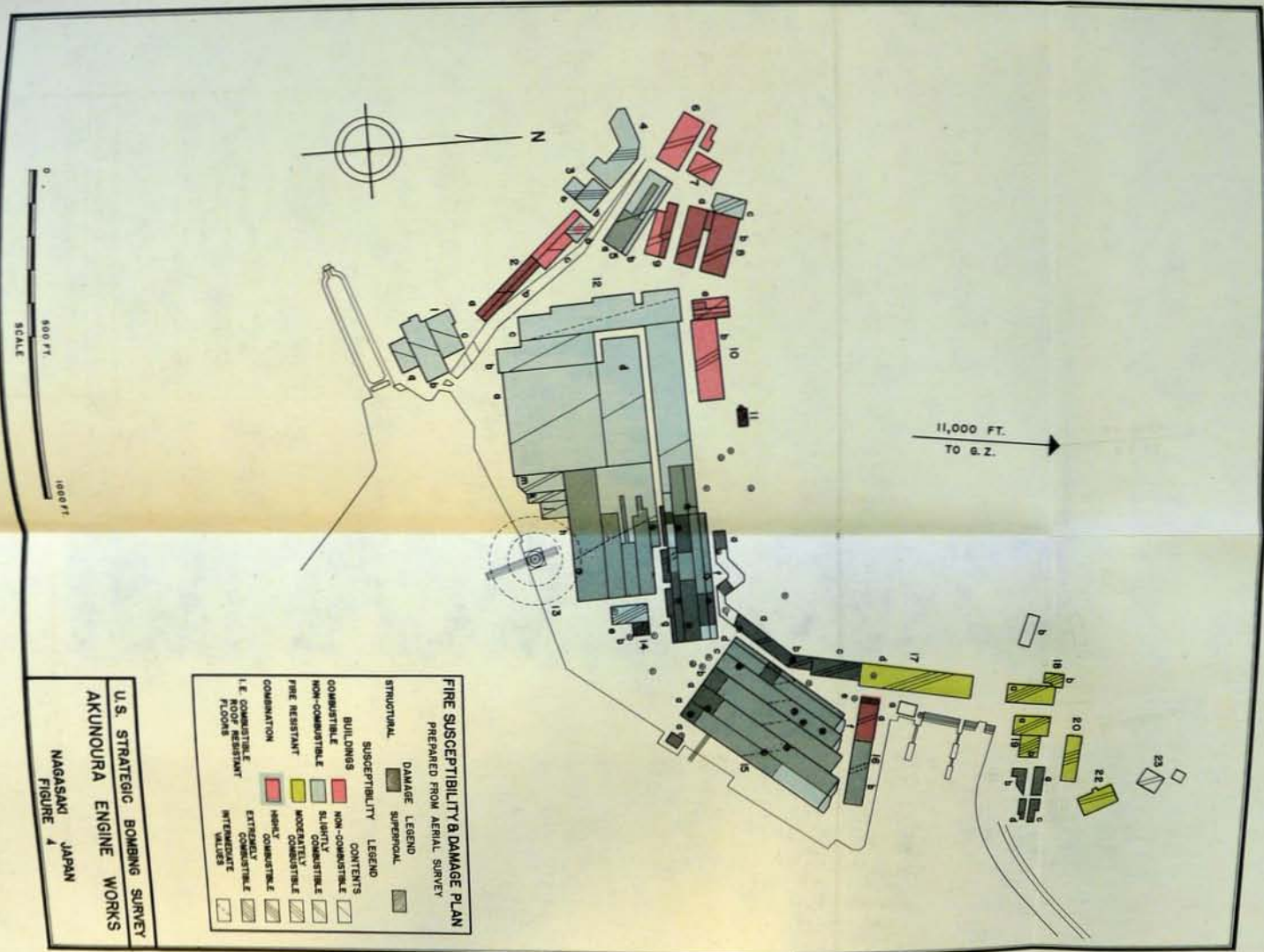
## VIII. GENERAL PHOTOGRAPHS

1. The following photographs are included because of their general interest to readers of this report.
2. Photos 18 through 24 show graphically the effect of the atomic bomb on Nagasaki. The arcs on the "after" photos indicate distances

from GZ in feet. The group number of some of the groups referred to in this report are also shown. 3. Photos 25 through 37 are scenes taken near GZ during the time of the survey.



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U.S. STRATEGIC BOMBING SURVEY  
AKUNOURA ENGINE WORKS  
NAGASAKI JAPAN  
FIGURE 4



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2. Photos 18 thr  
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PHOTO 18.—Before and after: 7 and 12 August 1945.



PHOTO 19.—Before and after: 7 and 12 August 1945.



PHOTO 20.—Before and after: 7 and 12 August 1945.



PHOTO 21.—Before and after: 7 and 12 August 1945.



PHOTO 22.—Before and after: 7 and 12 August 1945.



PHOTO 23.—Before and after: 7 and 12 August 1945.



PHOTO 24.—Before and after: 7 and 12 August 1945.



PHOTO 25.—Looking southeast from a point directly over the Nagasaki Prison-Group 13. This hillside was crowded with typical Japanese wood frame houses. In the upper portion of the photo can be seen the northwest corner of the Nagasaki Medical College (Group 17).



PHOTO 26.—Looking northwest from Ground Zero. Trees were stripped, and branches were broken downward. Low brick wall in the middle distance was demolished. Note cave shelters in the hillside. Nagasaki Prison (Group 13) can be seen in the upper right corner.



PHOTO 27.—Looking north from Ground Zero. Shack in the middle left foreground was recently erected. Reading from left to right, can be seen bridge 24, the Blind and Dumb School (Group 14) and the Parochial School (Group 15). Note grass growing in lower left corner of photo.

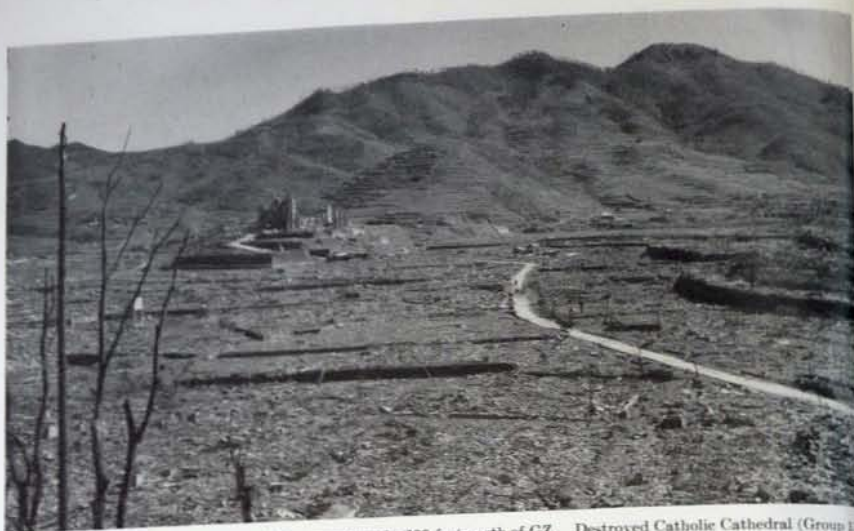


PHOTO 28.—Looking east from a point approximately 200 feet north of GZ. Destroyed Catholic Cathedral (Group 11) on hill.



PHOTO 29.—Looking west from a point near Group 15. Chinzei School (Group 18) to left of center of photo.



PHOTO 30.—Looking southeast from Ground Zero. This hillside was completely covered with typical Japanese wood frame residences. Note damaged retaining walls.



PHOTO 31.—Looking south from Ground Zero. Crude retaining walls were smashed and the hillsides have given away. Ground Zero was established at the air raid shelter in the center of the photo.



PHOTO 32.—Looking south from Ground Zero. Ground Zero was established at the air raid shelter in the left center of the photo.



PHOTO 33.—Looking south-southwest from Ground Zero. The stacks of the Mitsubishi Steel and Arms Works (Group 26) can be seen in the distance. To the right of center, can be seen Chinzei High School (Group 18).



PHOTO 34.—Looking southwest from Ground Zero. In the distance and to the left can be seen Keiho Boys' School (Group 25). Chinzei High School (Group 18) is in the center distance, while slightly to the right can be seen one of the few concrete smoke stacks that was destroyed by blast.



PHOTO 35.—Looking southwest from Ground Zero. Chinzei High School (Group 18), can be seen to the left.



PHOTO 36.—Looking west from Ground Zero. Shiroyama School (Group 16), can be seen in the distance.



PHOTO 37.—Looking northwest from Ground Zero. Note grass growing in the foreground.

# NAGASAKI

INSTRUCTION

SIS

DESTROYED

Damage Value

DISTANCE FROM G.Z.	NUMBER OF BUILDINGS	TOTAL PLAN AREA	TOTAL FLOOR AREA	HEAVY MACHINE SHOPS	LIGHT MACHINE SHOPS	FIRE CLASS C							
						MA Damaged Sq.	1000's of Sq. Ft. Damaged	1000's of Sq. Ft. Damaged	1000's of Sq. Ft. Damaged	1000's of Sq. Ft. Damaged	1000's of Sq. Ft. Damaged	1000's of Sq. Ft. Damaged	1000's of Sq. Ft. Damaged
FEET	1000's of Sq. Ft.	1000's of Sq. Ft.	1000's of Sq. Ft.	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*	No. Liable Bldgs. Area*
0-1000													
1000-2000													
2000-3000													
3000-4000	8	23	28			1							
4000-5000	3	17	17			2							
5000-6000	5	62	62			3							
6000-7000													
7000-8000													
8000-9000													
9000-10000	1	5	5										
10000-11000													
11000-12000	5	27	32			1							
12000-13000	2	10	10			2							
13000-14000	1	2	4										
14000-15000													
15000-16000													
16000-17000													
17000-18000	1	150	160										
18000-19000													
19000-20000	3	2	2										
TOTALS	26	298	328										

735212 O - 47 (Face p. 94)

No. 10

1987; Smith et al. 1990).

A3A17

NAGASAKI

## HEAVY STEEL CONSTRUCTION

## DAMAGE ANALYSIS

FIRE CLASS A		FIRE CLASS B		FIRE CLASS C	
HEAVY MACHINE SHOPS	LIGHT MACHINE SHOPS	STORAGE & OFFICES	PUBLIC BUILDINGS	HEAVY MACHINE SHOPS	LIGHT MACHINE SHOPS
1000's of Sq Ft Damaged Blast & Fire Blast & Fire Blast & Fire	1000's of Sq Ft Damaged Blast & Fire Blast & Fire Blast & Fire	1000's of Sq Ft Damaged Blast & Fire Blast & Fire Blast & Fire	1000's of Sq Ft Damaged Blast & Fire Blast & Fire Blast & Fire	1000's of Sq Ft Damaged Blast & Fire Blast & Fire Blast & Fire	1000's of Sq Ft Damaged Blast & Fire Blast & Fire Blast & Fire
1.0	11	5			
4.5				75	
1.8		10			
	9				
	16	1			
87	86	41			74

NAGASAKI

NAVY STEEL CONSTRUCTION

# DAMAGE ANALYSIS

	FIRE CLASS. M				FIRE CLASS. S			
	SUPERFICIAL		INTERIOR		SUPERFICIAL		INTERIOR	
	HEAVY MACHINE SHOPS 1000's of Sq. Ft. Damaged	LIGHT MACHINE SHOPS 1000's of Sq. Ft. Damaged	STORAGE & OFFICES 1000's of Sq. Ft. Damaged	PUBLIC BUILDINGS 1000's of Sq. Ft. Damaged	HEAVY MACHINE SHOPS 1000's of Sq. Ft. Damaged	LIGHT MACHINE SHOPS 1000's of Sq. Ft. Damaged	STORAGE & OFFICES 1000's of Sq. Ft. Damaged	PUBLIC BUILDINGS 1000's of Sq. Ft. Damaged
	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.	Blst. & Fire Bldgs. Ctx.
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100								



**CONCLUSIONS**



## STRUCTURAL

[illegible]

THESE ARE THE RESULTS OF THE INVESTIGATION

RECEIVED THIS UNIT

UNCLASSIFIED

195312 O - 47 (Face p. 78)

**SECRET**

1

**Dr. O'Connell**

in thousands of acres, east

1

## DAMAGE ANALYSIS

[illegible]

PRICE ON CONCRETE AND STEEL CONSTRUCTION

### STRUCTURAL

[illegible]

**SCORE**

BUICK LEAD BEARING WATTS - WOOD PLANK

CHICKEN

\*In thousands of square feet

136212 O - 47 (Group B-56)

## DAMAGE ANALYSIS

**950-0768**

**ALPHANUMERIC CONTACT**

## DAMAGE ANALYSIS

### Subcommittee

**SECRET**

26611E

STANDARD FORM NO. 64

INVESTMENT

REINFORCED CONCRETE

FORM 10-65
U.S. GOVERNMENT PRINTING OFFICE: 1965

001	9	02	2			299	29	818	88	001	6			0091	008	08	57920
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105112 O - 47 (Page 2-30)

PRICE LOW SEATING WALLS - WOOD FRAMES

## DAMAGE ANALYSIS

[illegible]

**STANDARD T**



THICK LOAD SHAKING TABLES - WOOD FRAME

## DAMAGE ANALYSIS

[illegible]

# PART 2 EFFECTS OF THE ATOMIC BOMB ON INDUSTRIAL STRUCTURES

I. Object of study	99
II. Summary of damage	99
III. General information	100
IV. Damage analysis	101
Frontispiece:	
Figures 1 to 40, inclusive.	
Photographs 1 to 298, inclusive.	



FRONTISPIECE

"... reconstruction of these plants is extremely difficult and has not yet been started."

Nagasaki Prefecture Report

The object of the survey made on the buildings covered in this part was to determine the effect of the atomic bomb on industrial structures constructed at various distances from ground zero

## II. SUMMARY OF DAMAGE

1. The principal industries in Nagasaki were shipbuilding and ship repair, arms and munitions manufacturing, electric manufacturing, and miscellaneous industries of many types. They were located in the Urakami River valley and along the banks of Nagasaki Bay. It was estimated by the Joint Target Group (JTG) that approximately 10 percent of the total Japanese shipbuilding and repair facilities, and approximately 7 percent of the Japanese arms and munitions production were located in Nagasaki. The buildings housing these different industries were similar in construction to those used for the same purposes in America or Europe.

2. Many school buildings and other public buildings were converted into small machine shops during the war, but these structures are not included herein, since they are described in Part 3 of this report. A general summary of the effects of the bomb and the causes thereof on all types of structures is included in Part 1.

3. The industrial installations surveyed in the city of Nagasaki consisted of 281 structures in 30 groups, and extended 5,500 feet to the north and 20,000 feet to the south of GZ. The total floor space occupied by these industries was approximately 5,400,000 square feet, and the buildings were of different types, with steel-frame structures predominating. The total floor areas are as follows:

	Square feet	Percent of total
Heavy steel-frame	1,932,000	36
Light steel-frame	1,719,000	32
Reinforced-concrete	688,000	13
Mixed concrete-and-steel	290,000	5
Wall-bearing brick	113,000	2
Wood-frame	678,000	12

4. **Steel Frame.**—The steel-frame structures varied in construction from the light shed type to those built of heavy lattice, box-type columns and containing heavy crane rails. The damage to these buildings depended on several factors: Distance from GZ, strength of structure, relation

(GZ represents a point on the earth's surface vertically below the point of detonation of the atomic bomb).

of the long axis of the building to GZ, and sheltering effect of near-by buildings or hills. Buildings covered with corrugated asbestos suffered less damage to the steel frame than those having roofing or siding of corrugated or sheet iron, since blast pressure easily broke the brittle asbestos and allowed the pressure to equalize quickly around the members of the framework; whereas metal side and roof covering offered more resistance to the blast and transmitted a greater pressure to the structure. Heavy steel-frame structures with the long axis at right angles to the force of the blast were distorted more than those with the long axis parallel to the direction of blast. Some buildings with light steel pitched roofs or with saw-tooth roofs were completely demolished as far as 6,500 feet from GZ. Beyond that distance no steel-frame buildings suffered structural damage. The average radius for structural damage to steel-frame buildings was approximately 4,600 feet.

5. One steel-frame industrial building was structurally damaged, principally by fire. This was Building 1 at the Mitsubishi Woodworking Plant (Group 35), which contained large stores of wood on heavy wooden flooring. The fire in this combustible material softened the steel members of the building and caused a general over-all collapse of the structure.

6. Within a radius of 7,000 feet from GZ there were 55 steel-frame buildings with a total floor area of 1,657,000 square feet. Data on these buildings are listed in Table 1.

7. **Reinforced-Concrete.**—Reinforced-concrete buildings at industrial installations were generally used for offices or storage. There were no buildings of this type destroyed or structurally damaged beyond 5,000 feet from GZ. Only one reinforced-concrete building housing an industry was exposed to the blast within 3,000 feet of GZ. The extent of damage depended upon the distance from GZ and the design and quality of the buildings. Concrete buildings at Mitsubishi Steel and Arms

TABLE 1

Type building	Distance from GZ (feet)	Number of buildings	Original floor area (square feet)	Destroyed or structurally damaged floor area	
				Square feet	Percent
Steel-frame	1,000-2,000	8	167,000	162,000	97
	2,000-3,000	2	20,000	11,000	55
	3,000-4,000	11	193,000	72,000	37
	4,000-5,000	24	945,000	598,000	63
	5,000-6,000	7	319,000	66,000	21
	6,000-7,000	3	13,000	11,000	85
Reinforced concrete	1,000-2,000	1	18,000	14,000	78
	3,000-4,000	5	114,000	12,000	11
	4,000-5,000	10	187,000	92,000	49
	5,000-6,000	5	18,000	0	0
Mixed concrete and steel	3,000-4,000	2	9,000	1,000	11
	4,000-5,000	2	5,000	1,000	20
	5,000-6,000	3	58,000	4,000	7
Load-bearing brick wall	4,000-5,000	4	16,000	14,000	88
	5,000-6,000	6	25,000	25,000	100
	6,000-7,000	3	16,000	13,000	81
	10,000-11,000	2	9,000	0	0
Wood-frame	1,000-2,000	1	13,000	13,000	100
	3,000-4,000	12	131,000	118,000	90
	4,000-5,000	19	78,000	78,000	100
	5,000-6,000	6	98,000	98,000	100
	6,000-7,000	8	30,000	30,000	100
	7,000-8,000	1	2,000	2,000	100
	8,000-9,000	11	49,000	40,000	82
	9,000-10,000	5	113,000	15,000	13

Plant (Group 26), 4,700 feet from GZ, constructed with thin arched roofs were badly damaged, while others of heavy beam-and-slab construction in the same locality suffered only minor damage. Data concerning reinforced-concrete buildings are contained in Table 1.

**8. Mixed Concrete-and-Steel.**—Of the 19 mixed concrete-and-steel buildings in industrial groups, none were structurally damaged beyond 6,000 feet of GZ. These buildings were constructed with concrete walls and columns and steel roof trusses, or with intermediate steel floor beams. None of these buildings were within 3,000 feet of GZ. Data concerning mixed concrete-and-steel buildings are contained in Table 1.

**9. Wall-Bearing Brick.**—Twenty-two buildings

surveyed in Nagasaki were constructed with brick load-bearing walls and used to house industries. Structural damage to this type of structure extended to 7,000 feet from GZ, since they were very susceptible to blast. The 13 buildings within this radius, their total floor areas, their relation to GZ, and the damage they sustained are listed in Table 1.

**10. Wood Frame.**—There were 78 industrial buildings of wood-frame construction surveyed in Nagasaki. These structures suffered fire as well as blast damage, and it was not always possible to determine which was the principal cause of damage. Structural damage to these industrial buildings occurred within a 10,000-foot radius of GZ. Data concerning wood-frame buildings are contained in Table 1.

### III. GENERAL INFORMATION

1. The actual inspection of the buildings included in this volume was made in Nagasaki by the following personnel:

Capt. L. E. Orin, CE, AUS.  
Lt. W. J. Walsh, CEC, USNR.  
Lt. P. M. Speake, USNR.

2. The period of survey was approximately 10 days, 14 October to 18 November 1945.

3. The information was obtained by visual inspection of the structures included. In some cases, Japanese drawings were used as a basis for the drawings used in this report, but all of these drawings were checked for accuracy.

### IV. DAMAGE ANALYSIS

1. The insert map of Nagasaki in an envelope at the end of this part) shows 94 principal groups of buildings (other than dwellings), most of which were selected for detailed study.

2. Of the 94 groups, 30 were industrial. They are listed below:

Group	Name	Described in paragraph
1	Mitsubishi Torpedo Works	5
2	Mitsubishi Turbine Component Works No. 2	6
3	Ohashi Gas Works	7
4	Area west of railroad and highway	8
5	Mitsubishi steel and arms plant	9
6	Mitsubishi steel and arms casting plant	10
7	Zenka substation	11
8	Mitsubishi woodworking plant	12
9	Mitsubishi Turbine Component Works No. 1	13
10	Kyushu electric power plant	14
11	Standard-Vacuum Oil Works	15
12	Yachiyo Machi Gas Works	16
13	Nagasaki station and freight yard	17
14	Ice plant	18
15	Mitsubishi Electric Manufacturing Co.	19
16	Takenokubo substation	20
17	Akunoura Engine Works	21
18	Mitsubishi dockyard	22
19	Taegami shipyard	23
20	Otao shipyard	24
21	Kozaki Point oil storage	25
22	Tobacco Monopoly Agency	26
23	Dejima Wharf	27
24	Mitsubishi Trading Co.	28
25	Mitsubishi small shipbuilding works	29
26	Mitsubishi small boat yard	30
27	Torpedo boat manufacturing plant	31
28	Nippon Oil Co.	32
29	Powder magazine	33

3. In general, there will be for any one group:

a. A brief description of the group (supplemented in some cases by a table "Building classification").

b. A plot plan and drawings of the important buildings.

c. "Damage analysis" sheets listing the data for each building.

d. Pertinent photos at the end of this part.

4. **Symbols.**—The Reference Tables immediately preceding Part 1 of this volume list the symbols and explanations thereof for types of damage, building types or classifications, high-explosive vulnerability classes, and fire classification.

#### 5. Mitsubishi Torpedo Works—Group 4.

a. This group of buildings was used to house machinery and facilities for the manufacture, assembly and testing of torpedoes. It was situated due north of GZ, the north and south boundaries being at distances of 5,500 feet and 3,600 feet, respectively.

b. The buildings covered a total plan area of approximately 795,000 square feet, and comprised a total floor area of approximately 870,000 square feet. The types of buildings and fire classifications are listed on following page.

c. Damage to this group ranged from minor damage in some reinforced-concrete structures to complete collapse of wooden and steel-frame buildings. None of the buildings escaped damage to some degree.

d. Of the 14 steel-frame buildings in the group, 11 (Buildings 4, 5, 5A, 10, 11, 20, 21, 22, 23, 25, and 34) sustained structural damage and the remaining three (Buildings 2, 7, and 8) suffered superficial damage to the roofing and siding. Almost all of the damage was caused by blast, although a small fire may have contributed to the collapse of columns in Building 10.

e. Of the four reinforced-concrete buildings in the group, none was structurally damaged. Two of these (Buildings 18 and 28) sustained superficial damage, caused by blast in Building 18 and by blast and fire in Building 28. Only minor damage, consisting of broken glass and displaced partition walls and window frames, occurred in Buildings 3 and 13.

f. Of the six structures built of concrete and steel, one (Building 8A) was a coal conveyor and was undamaged. Four (Buildings 1, 24, 35, and 36) were structurally damaged by blast. Building 19 sustained superficial damage only to the exterior walls.

g. There were 16 wood-frame buildings located at the site, all of which sustained structural damage. In 6 of these (Buildings 6, 9D, 16, 17, 26, and 27) fire contributed to damage. The remaining 10 structures were damaged by blast only.

h. Dwellings fringing the boundary of the group were not burned, nor were dwellings immediately

to the north. To the south there was a considerable area of fire damage to dwellings.  
i. Fire protection within the group was afforded by a private hydrant system fed by city water,

and by static tanks, hand pumps, and extinguishers manned by a private fire brigade.

j. Following is a summary fire damage to buildings and contents:

Building No.	Occupancy	Fire class	Estimated damage		
			Blast and fire, buildings		Fire, contents
			Superficial	Structural	
6.	Shop	C	Total	Total	Total
9D.	do	C	Serious	Serious	Serious
10.	Machine shop	N	Moderate	Moderate	Slight
16.	Storage	C	do	do	Do.
17.	do	C	do	do	Do.
26.	Laboratory	C	do	do	Do.
27.	Office	C	do	do	Do.
28.	do	R	Slight	None	Serious.

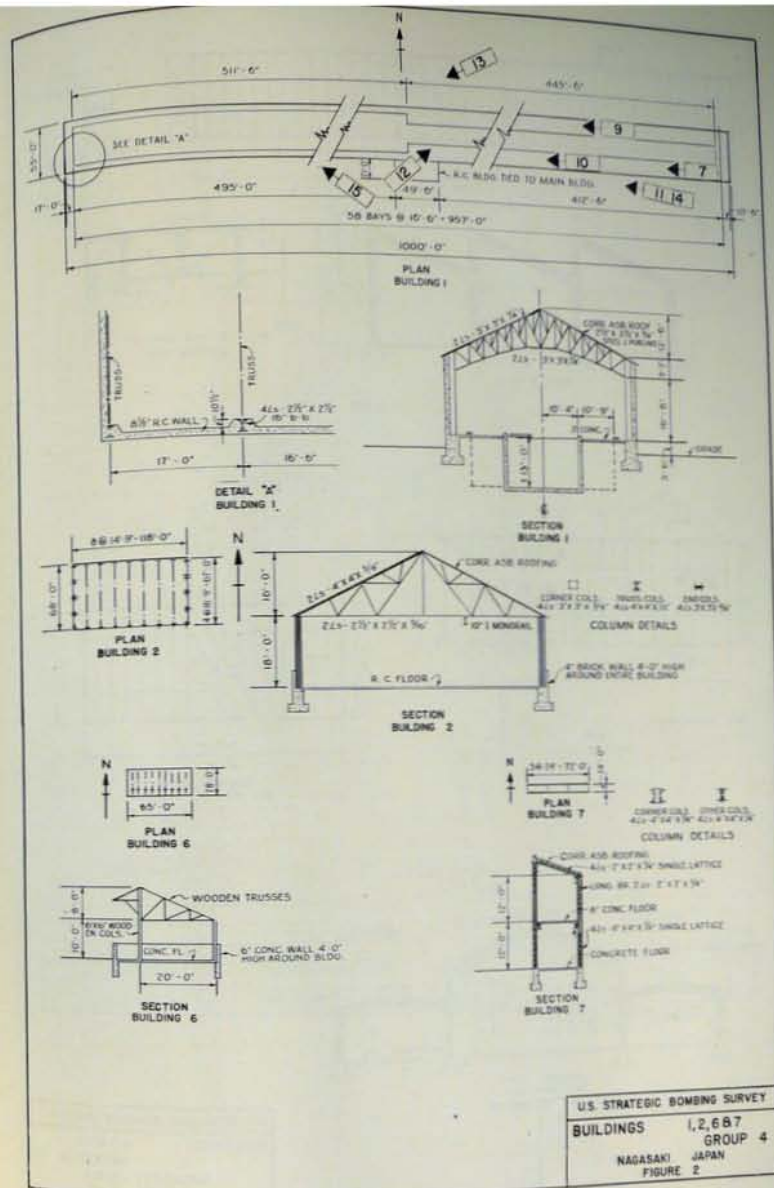
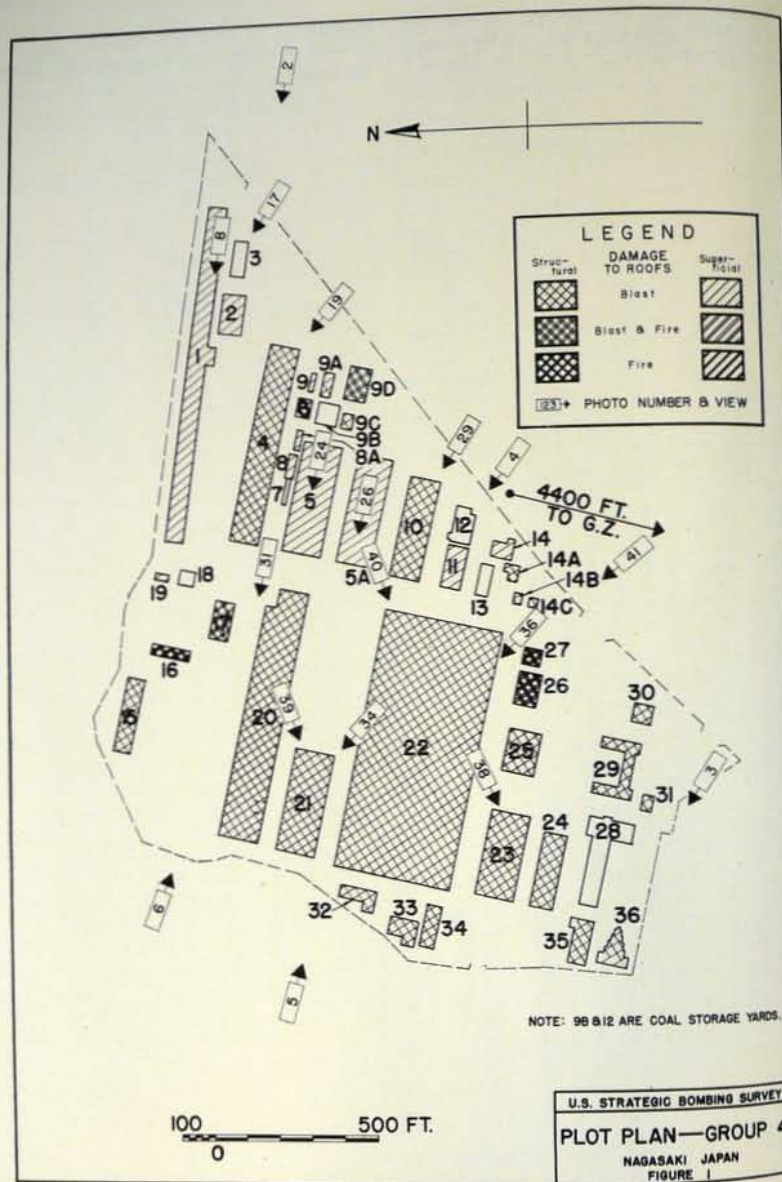
#### Building classification—Group 4

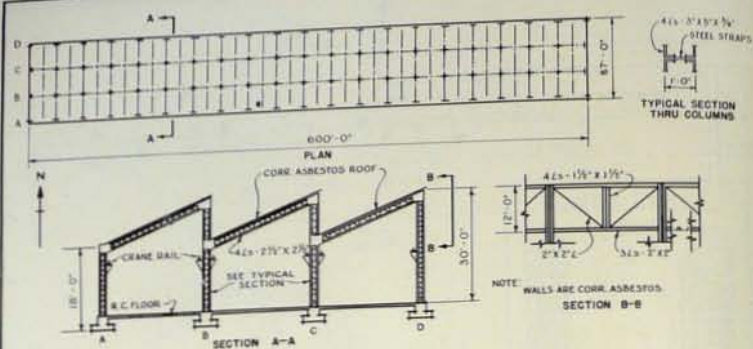
Building No.	Area		Type	Fire class	Construction			
	Plan (square feet)	Total (square feet)			Steel frame	Reinforced concrete	Concrete and steel	Wood
1.	55,000	55,000	A2.3	N			X	
2.	8,000	8,000	D	N	X			
3.	3,740	11,220	E1	R		X		
4.	52,200	52,200	B2	N	X			
5.	36,000	36,000	B2	N	X			
5A	41,400	41,400	B2	N	X			
6.	1,820	1,820	D	N	X			X
7.	1,000	2,000	E2	N	X			
8.	1,300	2,600	E2	N	X		X	
8A	1,300	1,300	S	R				X
9.	1,020	1,020	D	C				X
9A	600	600	D	C				
9B <sup>1</sup>	1,100	1,100	D	C				X
9C	5,200	5,200	D	C				X
9D	26,100	26,100	B2	N	X			
10.	7,200	7,200	D	N	X			
11								
12 <sup>1</sup>	3,150	3,150	D	R		X		
13.	2,000	2,000	D	C				X
14.	10,400	10,400	A1.1	C				X
15.	3,150	3,150	D	C				X
16.	14,000	14,000	A2.3	C				X
17.	1,480	1,480	D	R		X		
18.	1,040	1,040	D	N			X	
19.	90,000	90,000	B2	N	X			
20.	33,400	33,400	B2	N	X			
21.	264,000	264,000	B2	C	X			
22.	28,800	28,800	B2	C	X			
23.	12,000	12,000	B2	N&R			X	
24.	10,800	10,800	A1	C	X			X
25.	5,940	5,940	D	C				X
26.	2,790	2,790	D	C				X
27.	26,700	80,100	E2	R		X		X
28.	10,000	10,000	D	C				X
29.	3,500	3,500	D	C				X
30.	1,200	1,200	D	C				X
31.	4,700	9,400	D	C				X
32.	5,000	5,000	D	C				X
33.	4,950	4,950	D	C	X			
34.	7,800	15,600	F2	C			X	
35.	5,200	5,200	D	C			X	
36								
Total	794,980	870,660			14	4	6	16

<sup>1</sup> Coal-storage bin—no building.

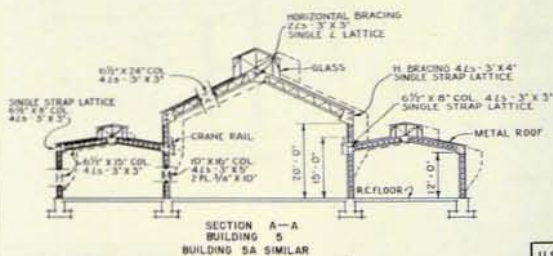
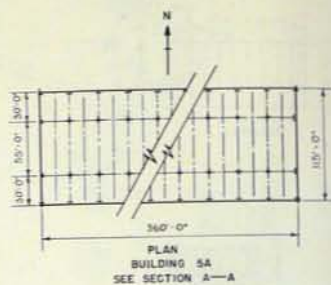
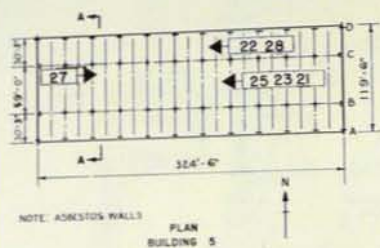
k. Further information regarding the construction of the buildings in this group, and the damage sustained by them will be found in Photos 1

through 53, in Figures 1 through 9 and on the damage analysis sheets immediately following the figures.





BUILDING 4



U.S. STRATEGIC BOMBING SURVEY  
BUILDINGS 4, 5, 8, 5A  
GROUP 4  
NAGASAKI JAPAN  
FIGURE 3

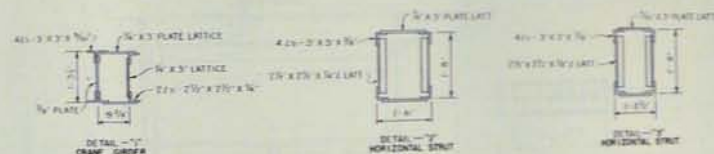
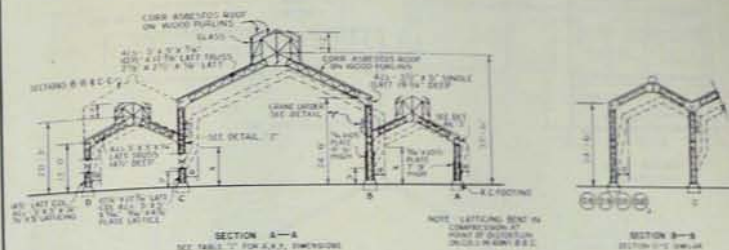
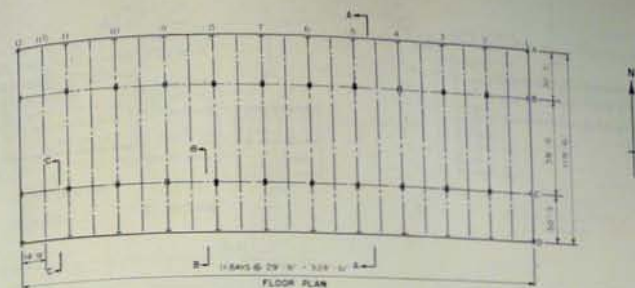
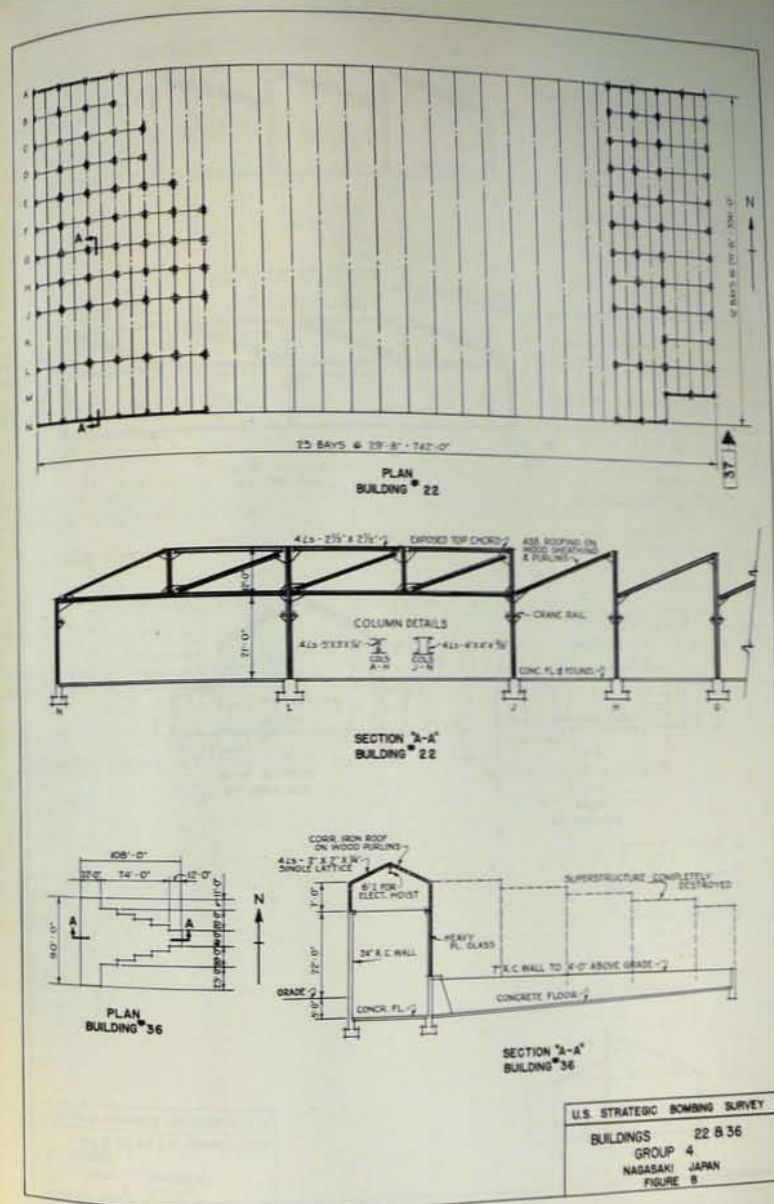
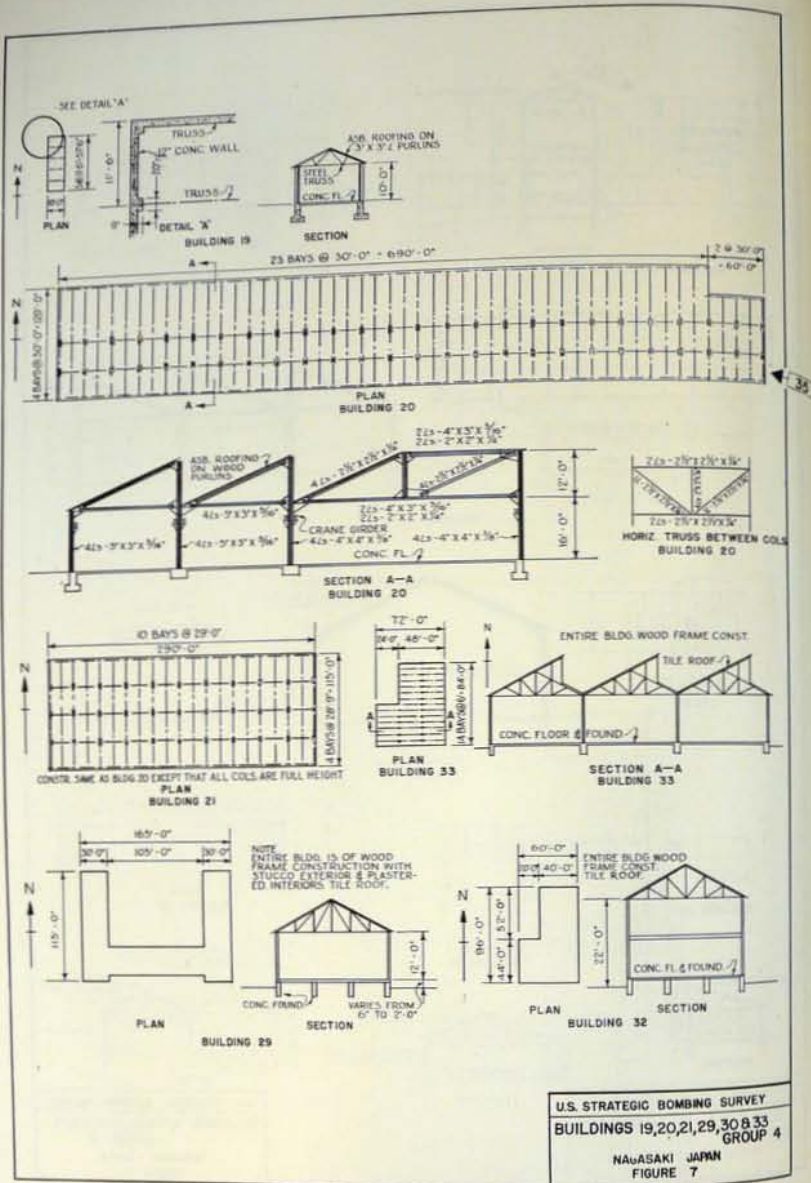
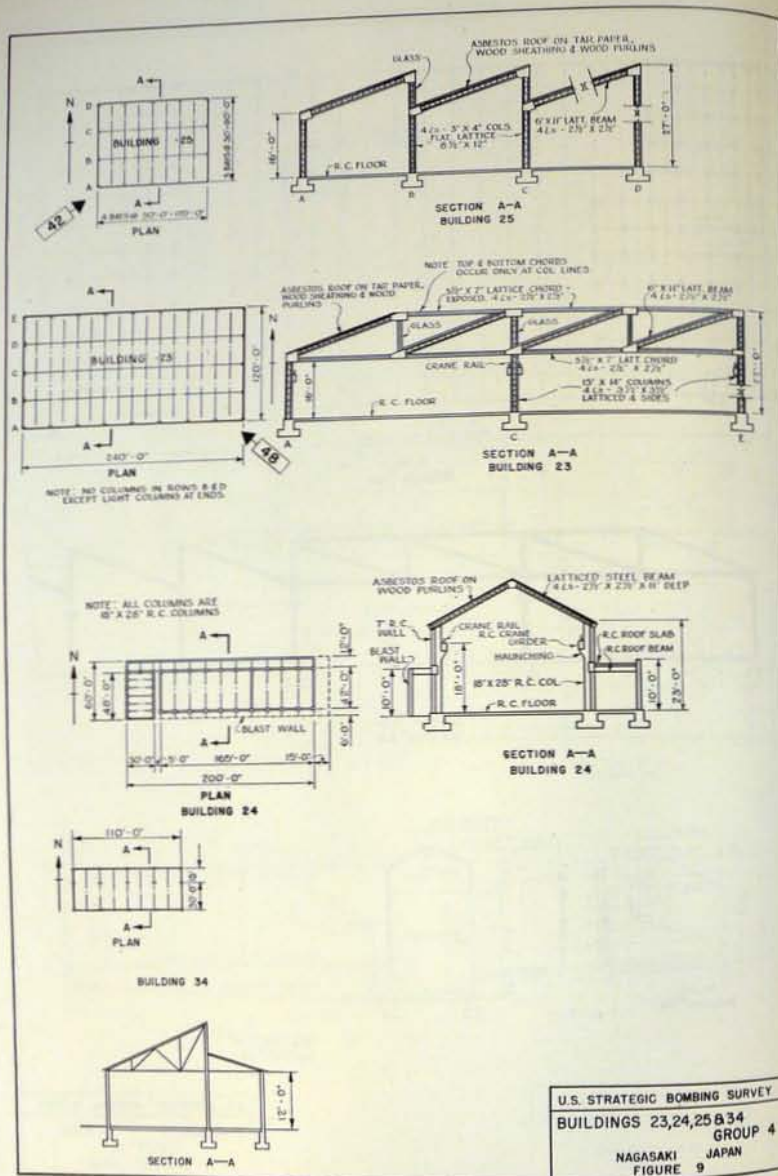


TABLE 1	
COLUMN NUMBERS	
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55	56
57	58
59	60
61	62
63	64
65	66
67	68
69	70
71	72
73	74
75	76
77	78
79	80
81	82
83	84
85	86
87	88
89	90
91	92
93	94
95	96
97	98
99	100

U.S. STRATEGIC BOMBING SURVEY  
BUILDING 5 GROUP 4  
NAGASAKI JAPAN  
FIGURE 4







## DAMAGE ANALYSIS

Dimensions, floor: 1,000 by 55 feet.  
Ground floor area: 55,000 square feet.  
Total area: 55,000 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 15 feet.

Group: 4.  
Building No. 1.  
Occupancy: Model testing.  
Building type: Steel frame, concrete walls (A2-3).  
Fire classification: N.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	See Photo 8.
Trusses: Steel	0	95	do.	Failure of minor truss members only.
Columns: Steel	50	0	do.	South columns failed at truss and floor levels. North columns failed at truss and foundation levels. See Photos 9 and 10.
First floor: Concrete	30	0	do.	Section of north wall foundations rotated.
Foundation: Reinforced concrete	10	0	do.	Cracks at floor and truss levels. Building failed in a northerly direction. See Photos 11, 13, and 14.
Exterior walls: Reinforced concrete	85	0	do.	All glass gone. Frames damaged in south wall only.
Windows: Steel sash	0	100	do.	
Finish: Wood ceiling	0	100	do.	
Contents: Model testing apparatus	80	0	Debris and blast.	

Remarks: Figure 2; Photos 7, 8, 9, 10, 11, 12, 13, 14, and 15.

# DAMAGE ANALYSIS

Dimensions: 118 by 68 feet.  
Ground floor area: 8,000 square feet.  
Total area: 8,000 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 2.  
Occupancy: Machine shop (D).  
Building type: Steel frame.  
Fire classification: N.  
Ground Zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Building collapsed to north. Photo 19.
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete on earth	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated iron	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: Lathes, monorail	5	0	do	

Remarks: Figure 2; Photo 16.

# DAMAGE ANALYSIS

Dimensions: 107 by 35 feet.  
Ground floor area: 3,740 square feet.  
Total area: 7,480 square feet.  
Number of floors: 2.  
Eave height: 37 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 3.  
Occupancy: Office and engineering department (E1).  
Building type: R/C.  
Fire classification: R.  
Ground Zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete	0	0		Columns bent north. Photos 21, 22, 23, 24, 25, 27, and 28.
Columns: Reinforced concrete	0	0		
Third floor: Reinforced concrete	0	0		
Second floor: Reinforced concrete	0	0		
First floor: Reinforced concrete	0	0		
Basement: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Interior walls: Lath and plaster	0	80	Blast	
Windows: Steel sash	0	100	do	
Contents: Office furniture	0	0		

Remarks: Figure 5; Photos 17 and 18.

# DAMAGE ANALYSIS

Dimensions: 600 by 87 feet.  
Ground floor area: 52,200 square feet.  
Total area: 52,200 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 5 feet.

Group 4.  
Building No. 4.  
Occupancy: Torpedo assembly.  
Building type: Light steel (B2).  
Fire classification: N.  
Ground zero: 5,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Building collapsed to north. Photo 19.
Trusses: Steel	95	0	do	
Columns: Steel	65	0	do	
1st floor: Concrete	40	0	do	
Foundation: Concrete	50	0	do	
Exterior walls: Corrugated asbestos	0	100	do	
Windows: Steel sash	0	100	do	

Remarks: Figure 3; Photo 19.

# DAMAGE ANALYSIS

Dimensions: 330 by 109 feet.  
Ground floor area: 36,000 square feet.  
Total area: 36,000 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 5.  
Occupancy: Steel pressing.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 5,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Derailed and dropped to ground floor.
Trusses: Steel	5	0	do	
Columns: Steel	90	0	do	
1st floor: Concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated asbestos	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: Crane	5	10	do	

Remarks: Figure 4; Photos 21, 22, 23, 24, 25, 27, and 28.

# DAMAGE ANALYSIS

Dimensions: 360 by 115 feet.  
Ground floor area: 41,400 square feet.  
Total area: 41,400 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 5A.  
Occupancy: Smelting.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Building collapsed to north. Photo 26.
Trusses: Steel	20	0	do	
Columns: Steel	90	0	do	
First floor: Concrete	0	0	Blast	
Foundation: Reinforced concrete	5	0	do	
Exterior walls: Corrugated asbestos	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Crane and electric furnace	60	0	do	

Remarks: Figure 3; Photo 26.

# DAMAGE ANALYSIS

Dimensions: 65 by 28 feet.  
Ground floor area: 1,820 square feet.  
Total area: 1,820 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 6.  
Occupancy: Blacksmith shop.  
Building type: Wood and asbestos (D).  
Fire classification: C.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Entire building blown north about 10 feet.
Trusses: Wood	100	0	Blast and fire	
Columns: Wood	100	0	do	
First floor: Concrete	0	0	Blast	
Foundation: Concrete	100	0	do	
Exterior walls: Corrugated asbestos	0	100	do	
Windows: Wood sash	0	100	do	
Contents: Blacksmith equipment	20	0	Debris	

Remarks: Figure 2.

# DAMAGE ANALYSIS

Dimensions: 72 by 14 feet.  
Ground floor area: 1,000 square feet.  
Total area: 2,000 square feet.  
Number of floors: 2.  
Eave height: 24 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 7.  
Occupancy: Gas-generating equipment.  
Building type: Steel frame (E2).  
Fire classification: N.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	
Trusses: Single steel member	0	0		
Columns: Steel	0	0		
Second floor: Steel and concrete	0	0		
First floor: Concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated asbestos	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: Gas-generating equipment	10	0	do	

Remarks: Figure 2; Photo 32.

# DAMAGE ANALYSIS

Dimensions: 65 by 20 feet.  
Ground floor area: 1,300 square feet.  
Total area: 2,600 square feet.  
Number of floors: 2.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 8.  
Occupancy: Gas generator.  
Building type: Steel frame (E2).  
Fire classification: N.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	
Trusses: Steel	0	0		
Columns: Steel	0	0		
Second floor: Reinforced concrete on steel	0	0		
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0	Blast	
Exterior walls: Corrugated asbestos	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Gas-generating equipment	10	0	do	

Remarks: Figure 6; Photo 32.

# DAMAGE ANALYSIS

Dimensions: 65 by 20 feet.  
Ground floor area: 1,300 square feet.  
Total area: 1,300 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 4.  
Building No. 8A.  
Occupancy: Coal storage and conveyor.  
Building type: S.  
Fire classification: R.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: None.				
Trusses: None.	0	0		
Columns: Steel.	0	0		
First floor: Reinforced concrete.	0	0		
Foundation: Reinforced concrete.	0	0		

Remarks: Photo 32.

# DAMAGE ANALYSIS

Dimensions: 60 by 17 feet.  
Ground floor area: 1,020 square feet.  
Total area: 1,020 square feet.  
Number of floors: 1.  
Eave height: 9 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 9.  
Occupancy: Wash room.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos.	1	100	Blast	Roof collapsed, westerly end of building blown north.
Trusses: Wood.	100	0	do	
Columns: Wood.	100	0	do	
First floor: Concrete.	0	0		
Foundation: Concrete.	0	0		
Exterior walls: Lath and plaster.	0	50	Blast	
Windows: Wood sash.	0	100	do	

# DAMAGE ANALYSIS

Dimensions: 33 by 18 feet.  
Ground floor area: 600 square feet.  
Total area: 600 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 9A.  
Occupancy: Electrical contract house and battery room.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Wood.	0	100	Blast	
Trusses: Wood.	50	0	do	
Columns: Wood.	95	0	do	
First floor: Concrete.	0	0		
Foundation: Concrete.	0	0		
Exterior walls: Wood.	0	95	Blast	
Windows: Wood sash.	0	100	do	
Contents: Contract equipment and batteries.	0	0		

Remarks: Figure 6.

# DAMAGE ANALYSIS

Dimensions: 55 by 20 feet.  
Ground floor area: 1,100 square feet.  
Total area: 1,100 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 9C.  
Occupancy: Small parts.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos.	0	100	Blast	Entire building blown north.
Trusses: Wood.	80	0	do	
Columns: Wood.	100	0	do	
First floor: Concrete.	0	0		
Foundation: Concrete.	40	0	Blast	
Exterior walls: Corrugated asbestos above 3-foot concrete wall.	0	100	do	
Windows: Wood sash.	0	100	do	
Contents: Parts, etc.	0	0		

Remarks: Figure 6.

# DAMAGE ANALYSIS

Dimensions: 115 by 45 feet.  
Ground floor area: 5,200 square feet.  
Total area: 5,200 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 4.  
Building No.: 9D.  
Occupancy: Shop.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	100	Fire and blast.	Building leans about 1 foot north. Photo 30.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete	0	0	do	
Foundation: Concrete	0	0	do	
Exterior walls: Wood	0	100	Blast	
Windows: Wood sash	0	100	do	

Remarks: Building completely destroyed.

# DAMAGE ANALYSIS

Dimensions: 300 by 87 feet.  
Ground floor area: 26,100 square feet.  
Total area: 26,100 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 10.  
Occupancy: Machine shop.  
Building type: Light steel frame (B2).  
Fire classification: N.  
Ground zero: 4,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Fire and blast.	Entire building blown north.
Trusses: Steel	100	0	do	
Columns: Steel	95	0	do	
First floor: Concrete	0	0	do	
Foundation: Concrete	5	0	do	
Exterior walls: Corrugated asbestos	0	100	Fire and blast.	
Windows: Steel sash	0	100	do	
Contents: Machine tools and cranes	0	0	do	

Remarks: Figure 6, Photo 29.

# DAMAGE ANALYSIS

Dimensions: 119 by 60 feet.  
Ground floor area: 7,200 square feet.  
Total area: 7,200 square feet.  
Number of floors: 1.  
Eave height: 37 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 11.  
Occupancy: Boiler house.  
Building Type: Steel frame (D).  
Fire Classification: N.  
Ground Zero: 4,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Building leans about 1 foot north. Photo 30.
Trusses: Steel	40	0	do	
Columns: Steel	80	0	do	
First floor: Concrete	0	0	do	
Foundation: Concrete	10	0	Blast	
Exterior walls: Corrugated asbestos	0	100	do	
Windows: Steel sash	0	100	do	
Contents: 4 boilers	40	0	do	

Remarks: Figure 6; Photo 30.

# DAMAGE ANALYSIS

Dimensions: 90 by 35 feet.  
Ground floor area: 3,150 square feet.  
Total area: 3,150 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 13.  
Occupancy: Switching Station.  
Building Type: Steel frame (D).  
Fire Classification: R.  
Ground Zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete	0	0	do	Earth filled blast walls outside.
Trusses: Reinforced concrete beams and girders	0	10	Blast	
Columns: Reinforced concrete	0	0	do	
First floor: Reinforced concrete	0	0	do	
Foundation: Reinforced concrete	0	0	do	
Exterior walls: Reinforced concrete	0	0	do	
Windows: Steel sash	0	100	Blast	
Contents: Switching equipment	0	0	do	

Remarks: Figure 5; Photo 33.

# DAMAGE ANALYSIS

Dimensions: 63 by 32 feet.  
Ground floor area: 2,000 square feet.  
Total area: 2,000 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 14.  
Occupancy: Auto repair garage.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Collapsed toward north. No fire damage.
Trusses: Wood	5	0	do	
Columns: Wood	100	0	do	
1st floor: Concrete	0	0		
Foundation: Reinforced concrete	5	0	Blast	
Exterior walls: Lath and plaster	0	100	do	
Windows: Wood sash	0	100	do	

Remarks: Figure 6.

# DAMAGE ANALYSIS

Dimensions: 216 by 48 feet.  
Ground floor area: 10,400 square feet.  
Total area: 10,400 square feet.  
Number of floors: 1.  
Eave height: 10 feet 6 inches.  
Mean elevation: 15 feet.

Group 4.  
Building No. 15.  
Occupancy: Pattern and light machine shop.  
Building type: Wood frame (A1.1).  
Fire classification: C.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Collapsed toward north. No fire damage.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
1st floor: Earth	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Wood and asbestos	0	100	Blast	
Windows: Wood sash	0	100	do	

Remarks: Figure 6.

# DAMAGE ANALYSIS

Dimensions: 90 by 35 feet.  
Ground floor area: 3,150 square feet.  
Total area: 3,150 square feet.  
Number of floors: 1.  
Eave height: Unknown.  
Mean elevation: 15 feet.

Group 4.  
Building No. 16.  
Occupancy: Cement shed.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	100	Fire	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
1st floor: Earth	100	0	do	
Foundation: None	0	100	do	
Exterior walls: Wood				

Remarks: Building completely demolished by fire.

# DAMAGE ANALYSIS

Dimensions: 235 by 60 feet.  
Ground floor area: 14,000 square feet.  
Total area: 14,000 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 4.  
Building No. 17.  
Occupancy: Store house.  
Building type: Wood frame (A2.3).  
Fire classification: C.  
Ground zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood and tile	0	100	Blast	
Trusses: Wood	90	0	Fire and blast	
Columns: Wood	100	0	do	
1st floor: Concrete				
Foundation: Reinforced concrete	60	0	Blast	
Exterior walls: Wood	0	100	Fire and blast	
Windows: Wood sash	0	100	do	

Remarks: Building completely demolished. Part of foundation wall and floor remaining.

# DAMAGE ANALYSIS

Dimensions: 46 by 32 feet.  
Ground floor area: 1,480 square feet.  
Total area: 1,480 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 18.  
Occupancy: Oil storage.  
Building type: Reinforced concrete beam and girder (D).  
Fire classification: R.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 8-inch reinforced concrete	0	0		
Columns: 18- by 18-inch reinforced concrete	0	0		
First floor: Reinforced concrete	0	0		
Foundation: 7-inch reinforced concrete	0	0		
Exterior walls: 7-inch reinforced concrete	5	0	Blast	Slight crack in south wall only.
Windows: Steel sash	0	100	do	
Contents: Barrels of oil	0	0		

Remarks: Figures 5: slight crack in south wall only.

# DAMAGE ANALYSIS

Dimensions: 58 by 18 feet.  
Ground floor area: 1,040 square feet.  
Total area: 1,040 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 19.  
Occupancy: Oil storage.  
Building type: Concrete and steel (D).  
Fire classification: N.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	All roof covering stripped
Trusses: Steel	0	100	do	
Columns: 20- by 21-inch reinforced concrete				
First floor: Reinforced concrete	0	0		
Foundation: 12-inch reinforced concrete	0	0		
Exterior walls: 12-inch reinforced concrete	0	20	Blast	Several cracks in south wall only.
Contents: Barrels of oil	0	0		

Remarks: Figure 7.

# DAMAGE ANALYSIS

Dimensions: 750 by 120 feet.  
Ground floor area: 90,000 square feet.  
Total area: 90,000 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 20.  
Occupancy: Machine shop.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 5,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos wood purlins	0	100	Blast	
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Concrete	0	0		
Foundation: Reinforced concrete	90	0	Blast	
Exterior walls: Corrugated asbestos	0	100	do	South wall fell north and sections of the north wall were pulled south. Photos 31 and 35.
Windows: Steel sash				
Contents: Machine tools and cranes	20	0	Blast and debris.	

Remarks: Figure 7; Photos 31 and 35.

# DAMAGE ANALYSIS

Dimensions: 290 by 115 feet.  
Ground floor area: 33,400 square feet.  
Total area: 33,400 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 21.  
Occupancy: Machine shop.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood	0	100	Blast	
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	Building flattened in a northerly direction. Photos 34 and 39.
First floor: Concrete	5	0	do	
Foundation: Reinforced concrete	10	0	do	
Exterior walls: Corrugated asbestos on wood	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Machine tools	85	0	do	

Remarks: Figure 7; Photos 34 and 39.

# DAMAGE ANALYSIS

Dimensions: 46 by 32 feet.  
Ground floor area: 1,480 square feet.  
Total area: 1,480 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 18.  
Occupancy: Oil storage.  
Building type: Reinforced concrete beam girder (D).  
Fire classification: R.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 8-inch reinforced concrete	0	0		Slight crack in south wall only.
Columns: 18- by 18-inch reinforced concrete	0	0		
First floor: Reinforced concrete	0	0		
Foundation: 7-inch reinforced concrete	0	0		
Exterior walls: 7-inch reinforced concrete	5	0	Blast	
Windows: Steel sash	0	100	do	
Contents: Barrels of oil	0	0		

Remarks: Figures 5; slight crack in south wall only.

# DAMAGE ANALYSIS

Dimensions: 58 by 18 feet.  
Ground floor area: 1,040 square feet.  
Total area: 1,040 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 19.  
Occupancy: Oil storage.  
Building type: Concrete and steel (D).  
Fire classification: N.  
Ground zero: 5,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	All roof covering stripped.
Trusses: Steel	0	100	do	
Columns: 20- by 21-inch reinforced concrete				
First floor: Reinforced concrete	0	0		Several cracks in south wall only.
Foundation: 12-inch reinforced concrete	0	0		
Exterior walls: 12-inch reinforced concrete	0	20	Blast	
Contents: Barrels of oil	0	0		

Remarks: Figure 7.

# DAMAGE ANALYSIS

Dimensions: 750 by 120 feet.  
Ground floor area: 90,000 square feet.  
Total area: 90,000 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 20.  
Occupancy: Machine shop.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 5,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos wood purlins	0	100	Blast	South wall fell north and sections of the north wall were pulled south. Photos 31 and 35.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Concrete	0	0		
Foundation: Reinforced concrete	90	0	Blast	
Exterior walls: Corrugated asbestos	0	100	do	
Windows: Steel sash				
Contents: Machine tools and cranes	20	0	Blast and debris.	

Remarks: Figure 7; Photos 31 and 35.

# DAMAGE ANALYSIS

Dimensions: 290 by 115 feet.  
Ground floor area: 33,400 square feet.  
Total area: 33,400 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 21.  
Occupancy: Machine shop.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood	0	100	Blast	Building flattened in a northerly direction. Photos 34 and 39.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Concrete	5	0	do	
Foundation: Reinforced concrete	10	0	do	
Exterior walls: Corrugated asbestos on wood	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Machine tools	85	0	do	

Remarks: Figure 7; Photos 34 and 39.

# DAMAGE ANALYSIS

Dimensions: 742 by 356 feet.  
Ground floor area: 264,000 square feet.  
Total area: 264,000 square feet.  
Number of floors: 1.  
Eave height: 21 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 22.  
Occupancy: Machining and assembly.  
Building type: Steel frame (B2).  
Fire classification: C.  
Ground zero: 4,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood sheathing.	0	100	Blast	Building collapsed to north row of columns comparatively unhurt. Photos 36, 37, 40, and 41.
Trusses: Steel	100	0	do	
Columns: Steel	90	0	do	
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	0	100	Blast	South wall bowed in at top and cracked.
Exterior walls: Corrugated asbestos on steel and wood framing.	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Machine tools and cranes	0	100	Blast and debris.	

Remarks: Figure 8; Photos 36, 37, 40, and 41.

# DAMAGE ANALYSIS

Dimensions: 240 by 120 feet.  
Ground floor area: 28,800 square feet.  
Total area: 28,800 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 23.  
Occupancy: Assembly.  
Building type: Steel frame (B2).  
Fire classification: C.  
Ground zero: 4,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood sheathing and purlins.	0	100	Blast	Building collapsed toward north.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated asbestos on wood nailers.	0	100	Blast	
Windows: Steel sash	0	100	do	

Remarks: Figure 9; Photos 38 and 48.

# DAMAGE ANALYSIS

Dimensions: 200 by 60 feet.  
Ground floor area: 12,000 square feet.  
Total area: 12,000 square feet.  
Number of floors: 1.  
Eave height: 23 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 24.  
Occupancy: Shops.  
Building type: Steel and concrete (B2).  
Fire classification: N and R.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos and reinforced concrete.	0	100	Blast	South wall bowed in at top and cracked.
Trusses: Steel	100	0	do	
Columns: 18- by 28-inch reinforced concrete.	40	0	do	
First floor reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		South wall bowed in at top and cracked.
Exterior walls: 7-inch reinforced concrete.	40		Blast	
Interior walls: 7-inch reinforced concrete.	0	0		
Windows: Steel sash	0	100	Blast	
Contents: 2 cranes	0	40	do	

Remarks: 10-foot-high blast wall in south and east sides. Figure 9.

# DAMAGE ANALYSIS

Dimensions: 120 by 90 feet.  
Ground floor area: 10,800 square feet.  
Total area: 10,800 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 25.  
Occupancy: Office and drafting.  
Building type: Steel frame (A1).  
Fire classification: C.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood sheathing and purlins.	0	100	Blast	No fire. Building canted and collapsed to north. Some columns still standing but all are bent. Photo 42.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	Blast	
First floor: Reinforced concrete	0	0		No fire. Building canted and collapsed to north. Some columns still standing but all are bent. Photo 42.
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated asbestos on wood nailers.	0	100	Blast	
Windows: Steel sash	0	100	do	

Remarks: Figure 9; Photo 42.

# DAMAGE ANALYSIS

Dimensions: 90 by 66 feet.  
Ground floor area: 5,940 square feet.  
Total area: 5,940 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 4.  
Building No. 26.  
Occupancy: Shop and laboratory.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood and tile	0	100	Fire	
Trusses: Wood	100	0	do	
Columns: Wood	0	0	do	
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Wood	0	100	Blast	
Windows: Wood sash	0	100	do	

Remarks: Building completely destroyed by fire.

# DAMAGE ANALYSIS

Dimensions: 58 by 48 feet.  
Ground floor area: 2,790 square feet.  
Total area: 2,790 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 4.  
Building No. 27.  
Occupancy: Office.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast and fire	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Wood	100	0	Fire	
Foundation: Reinforced concrete	0	0		
Exterior walls: Wood	0	100	Fire	
Interior walls: Wood	100	0	do	
Windows: Wood sash	0	100	do	
Contents: Not known	0	0		

Remarks: Building completely destroyed by fire.

# DAMAGE ANALYSIS

Dimensions: 225 by 118 feet.  
Ground floor area: 26,700 square feet.  
Total area: 80,100 square feet.  
Number of floors: 3.  
Eave height: 40 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 28.  
Occupancy: Offices and laboratories.  
Building type: Multistory concrete frame (E2).  
Fire classification: R.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete	0	0		Building structurally sound. Several internal fires in second and third floors. Interior walls blown down. Several rooms had wood-finish floors over concrete.
Columns: Exterior 26½ by 19-inch, interior 22½ by 19-inch reinforced concrete	0	0		
Third floor: Reinforced concrete	5	0	Blast	
Second floor: Reinforced concrete	0	0		
First floor: Reinforced concrete	15	0	Blast	
Foundation: Reinforced concrete	0	0		
Exterior walls: 6½-inch reinforced concrete	0	5	Blast	
Interior walls: Reinforced concrete and wood	0	60	Fire and blast	
Windows: Steel sash	0	100	Blast	
Finish	0	70	Fire	

Remarks: Earthquake-resistant construction. Figure 5; Photos 43, 44, 45, 46, 47, 49, and 53.

# DAMAGE ANALYSIS

Dimensions: 165 by 115 feet.  
Ground floor area: 10,000 square feet.  
Total area: 10,000 square feet.  
Number of floors: 1.  
Eave height: 13 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 29.  
Occupancy: Office.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast	Complete collapse toward north; no fire.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Wood	70	0	do	
Foundation: Reinforced concrete	0	0	do	
Exterior walls: Stucco outside, plaster inside	100	0	Blast	
Windows: Wood sash	0	100	do	
Finish	100	0	Blast	

Remarks: Figure 7.

# DAMAGE ANALYSIS

Dimensions: 70 by 50 feet.  
Ground floor area: 3,500 square feet.  
Total area: 3,500 square feet.  
Number of floors: 1.  
Eave height: Unknown.  
Mean elevation: 15 feet.

Group 4.  
Bldg. No. 30.  
Occupancy: Unknown.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast	Complete collapse toward north. No fire. Foundation wall cracked along south side.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Wood	100	0	Blast and debris	
Basement: Reinforced concrete				
Foundation: Reinforced concrete	20	0	Blast	
Exterior walls: Wood	0	100	do	
Windows: Wood sash	0	100	do	

# DAMAGE ANALYSIS

Dimensions: 47 by 26 feet.  
Ground floor area: 1,200 square feet.  
Total area: 1,200 square feet.  
Number of floors: 1, possibly 2.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 4.  
Building No. 31.  
Occupancy: Office.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast	Complete collapse toward north; no fire.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Wood	75	0	do	
Foundation: Reinforced concrete				
Exterior walls: Stucco outside plaster inside	0	100		
Windows: Wood sash	0	100		
Contents: Not known				

# DAMAGE ANALYSIS

Dimensions: 96 by 60 feet.  
Ground floor area: 4,700 square feet.  
Total area: 9,400 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 32.  
Occupancy: Storage.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast	Building demolished by blast; no fire. Photo 50.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
Second floor: Wood	100	0	do	
First floor: Reinforced concrete	0	10	do	
Foundation: Reinforced concrete	0	0	do	
Exterior walls: Wood	0	100	Blast	
Windows: Wood sash	0	100	do	

Remarks: Figure 7; Photo 50.

# DAMAGE ANALYSIS

Dimensions: 84 by 72 feet.  
Ground floor area: 5,000 square feet.  
Total area: 5,000 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 33.  
Occupancy: Unknown.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast	Building collapsed to north. Photo 50.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	0	0		
Exterior walls: Wood	0	100	Blast	
Windows: Wood sash	0	100	do	

Remarks: Figure 7; Photo 50.

# DAMAGE ANALYSIS

Dimensions: 110 by 45 feet.  
Ground floor area: 4,950 square feet.  
Total area: 4,950 square feet.  
Number of floors: 1.  
Eave Height: 12 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 34.  
Occupancy: Shop.  
Building type: Steel frame.  
Fire classification: C.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood purlins	0	100	Blast	Building collapsed to north. Photos 50 and 51.
Trusses: Steel	95	0	do	
Columns: Steel	100	0	do	
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated asbestos on wood girts	0	100	Blast	
Windows: Steel sash	0	100	do	

Remarks: Figure 9; Photos 50 and 51.

# DAMAGE ANALYSIS

Dimensions: 130 by 60 feet.  
Ground floor area: 7,800 square feet.  
Total area: 15,600 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 35.  
Occupancy: Office.  
Building type: Concrete and steel (F2).  
Fire classification: C.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood sheathing and wood purlins	0	100	Blast	Roof completely stripped.
Trusses: Single steel latticed members	5	40	do	South side members bowed down.
Columns: None; wall bearing	0	0		
Second floor: Reinforced concrete	0	0		
First floor: Reinforced concrete on earth	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Windows: Steel sash	0	60	Blast	All glass gone.

Remarks: Photo 52.

# DAMAGE ANALYSIS

Dimensions: 90 by 108 feet.  
Ground floor area: 5,200 square feet.  
Total area: 5,200 square feet.  
Number of floors: 1.  
Eave height: 29 feet.  
Mean elevation: 15 feet.

Group 4.  
Building No. 36.  
Occupancy: Test building.  
Building type: Steel, wood, and concrete frame (D).  
Fire classification: C.  
Ground zero: 3,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood and steel purlins	0	100	Blast	T-shaped building.
Trusses: Wood and steel	50	0	do	
Columns: None in westerly part, wood posts easterly part.	100	0	do	
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated asbestos on wood. Reinforced concrete westerly part.	0	100	Blast	
Windows: Wood sash	0	100	do	

Remarks: T-shaped building. Figure 8; Photo 52.

6. Mitsubishi Turbine Component Works No. 2—  
Group 5.

a. This group of buildings, situated due north of GZ at a distance of approximately 3,400 feet, was used to house machinery and equipment for the manufacture of turbine parts. The buildings covered a total plan area of approximately 106,000 square feet. The group consisted of one main wood-frame building, six other smaller wood-frame buildings, and two masonry buildings. The building areas, types, and classifications are listed below:

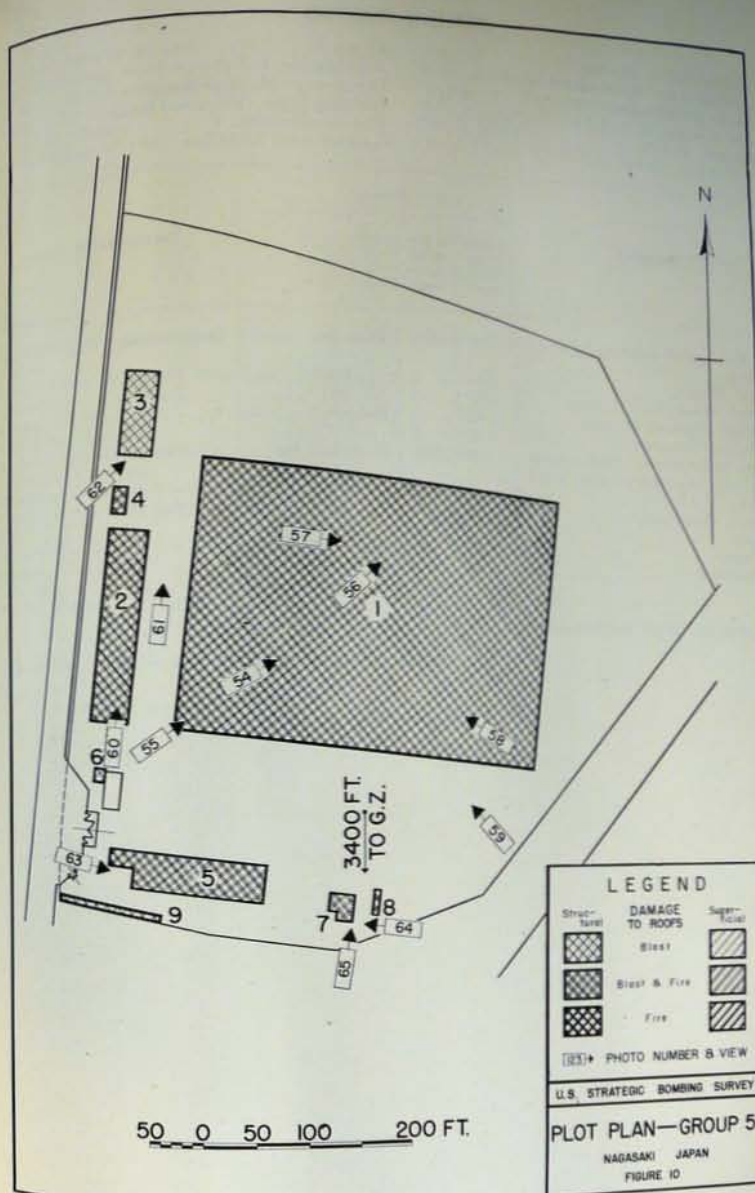
Building classification—Group 5

Building No.	Area		Type	Fire class	Construction	
	Plan (square feet)	Total (square feet)			Land-bearing wall	Wood
1	90,300	90,300	B2	C	---	X
2	6,480	12,960	E2	C	---	X
3	2,592	2,592	D	C	X	---
4	336	336	D	C	---	X
5	4,700	4,700	D	C	---	X
6	180	180	D	---	X	---
7	633	633	D	C	---	X
8	240	240	D	C	---	X
9	780	780	D	C	---	X
Total	106,241	112,721	---	---	2	7

b. All of the buildings in this group were structurally damaged. Fire contributed to the damage, except in Buildings 3, 6, and 9. All of the contents of Buildings 1, 2, 4, 5, 7, and 8 were consumed by fire.

c. Fire protection of the group consisted of a public fire department pumper, public water mains, private pump house adjacent to a static tank, several other small static tanks and portable hand pumps and fire extinguishers.

d. Damage to this group is shown on photos 54 through 65. Damage analysis sheets following the plot plan, figure 10, give further information concerning damage to these structures.



# DAMAGE ANALYSIS

Dimensions: 354 by 255 feet.  
Ground floor area: 90,300 square feet.  
Total area: 90,300 square feet.  
Number of floors: 1.  
Eave height: 26 feet.  
Mean elevation: 35 feet.

Group 5.  
Building No. 1.  
Occupancy: Machine shop.  
Building type: (B2) wood frame.  
Fire classification: C.  
Ground zero: 3,500 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Corrugated asbestos on wood purlins.	0	100	Blast and fire	Demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood	100	0	do	Do.
First floor: Concrete on earth.	0	5	Debris	
Foundation: Concrete	0	0		
Exterior walls: 8-inch brick (stuccoed) up to window sills; wood above.	0	100	Blast and fire	Do.
Windows: Wood sash	0	100	do	Do.
Contents: Cranes	0	50	Blast, fire, and debris.	
Machines	0	100		

Remarks: Entire building damaged; Photos 54, 55, 56, 57, and 58.

# DAMAGE ANALYSIS

Dimensions: 180 by 36 feet.  
Ground floor area: 6,480 square feet.  
Total area: 12,960 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 35 feet.

Group 5.  
Building No. 2.  
Occupancy: Wash house and refectory.  
Building type: Wood frame (E2).  
Fire classification:  
Ground zero: 3,400 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Corrugated asbestos on wood purlins.	0	100	Blast and fire	
Trusses: Wood, 8 feet, 7 inches oc (average).	100	0	do	
Columns: Wood	100	0	do	
Second floor: Wood	100	0	do	
First floor: Concrete on earth.	0	10	Debris	
Foundation: Concrete	0	0		
Exterior walls: Wood-frame weatherboards; 8-inch brick below window sills.	0	100	Blast and fire	
Interior walls: Wood	0	100	do	
Windows: Wood sash	0	100	do	
Finish: Wood	0	100	do	
Contents: Furniture	0	100	do	

Remarks: Entirely demolished and burned. Photo 60.

# DAMAGE ANALYSIS

Dimensions: 81 by 32 feet.  
Ground floor area: 2,592 square feet.  
Total area: 2,592 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 35 feet.

Group 5.  
Building No. 3.  
Occupancy: Boiler-transformer house.  
Building type: Wall-bearing (D) brick.  
Fire classification:  
Ground zero: 3,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood framing	0	100	Blast	Demolished.
Trusses: Wood	100	0	do	Do.
First floor: Concrete on earth	0	10	Debris	
Foundation: Concrete	0	0		
Exterior walls: 8-inch brick 4- by 12-inch interior pilasters at trusses (9 feet oc)	100	0	Blast	Do.
Interior walls: 8-inch brick	0	100	do	Do.
Windows: Wood sash	0	100	do	Do.

Remarks: Photo 62.

# DAMAGE ANALYSIS

Dimensions: 24 by 14 feet.  
Grade floor area: 336 square feet.  
Total area: 336 square feet.  
Number of floors: 1.  
Eave height not known.  
Mean elevation: 35 feet.

Group 5.  
Building No. 4.  
Occupancy: Toilets, lavatory.  
Building type: Wood-frame (D).  
Fire classification: C.  
Ground zero: 3,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood purlins	0	100	Blast and fire	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete on earth	0	10	Debris	
Foundation: Concrete	0	0		
Exterior walls: Wood	0	100	Blast and fire	
Interior walls: Wood	0	100	do	
Windows: Wood sash	0	100	do	
Contents: Plumbing fixtures	0	100	do	

Remarks: Building completely demolished; wood consumed by fire.

# DAMAGE ANALYSIS

Dimensions: 141 by 36 feet over all.  
Ground floor area: 4,700 square feet.  
Total area: 4,700 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 35 feet.

Group 5.  
Building No. 5.  
Occupancy: Offices.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood purlins	0	100	Blast and fire	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete on earth	0	5	Debris	
Foundation: Concrete	0	0		
Exterior walls: Wood stucco	0	100	Blast and fire	
Interior walls: Wood	0	100	do	
Windows: Wood sash	0	100	do	
Finish: Plaster, wood trim	0	100	do	
Contents: Office furniture	0	100	do	

Remarks: Completely demolished, burned and partly cleared away. Photo 63.

# DAMAGE ANALYSIS

Dimensions: 15 by 12 feet.  
Ground floor area: 180 square feet.  
Total area: 180 square feet.  
Number of floors: 1.  
Eave height: 6 feet.  
Mean elevation: 35 feet.

Group 5.  
Building No. 6.  
Occupancy: Water pump.  
Building type: Concrete wall-bearing (D).  
Fire classification: C.  
Ground zero: 3,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Unknown	0	100	Blast	Entirely gone; since replaced with temporary roof.
Trusses: Unknown	100	0	do	Do.
First floor: Concrete on earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete, 10 inches thick	0	0		
Interior walls:				
Contents: Pump	0	0		

Remarks: Static water basin adjoins, 16 by 36 by 3 feet; 6-inch concrete walls top flush with grade; no roof, no apparent damage.

# DAMAGE ANALYSIS

Dimensions: 25 by 27 feet over all.  
Ground floor area: 633 square feet.  
Total area: 633 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 35 feet.

Group 5.  
Building No. 7.  
Occupancy: Heat treatment, small parts.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: North 4/5: probably corrugated asbestos on wood. South 1/5: reinforced concrete slab.	20	80	Blast and fire	Slab overturned and cracked, remainder damaged and burned. Photos 64 and 65.
Trusses: Wood (North 4/5 only)	100	0	do	
Columns: Wood (North 4/5 only)	100	0	do	
First floor: Concrete on earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: North 4/5: CGI or asbestos on wood frame. South 1/5: 4-inch brick.	20	80	Blast and fire	
Interior walls: 4-inch brick (1 partition only).	0	100	Blast	
Windows: NA—probably none	0	0		
Contents: Small finished parts	100	0		

Remarks: Photos 64 and 65.

# DAMAGE ANALYSIS

Dimensions: 30 by 8 feet.  
Ground floor area: 240 square feet.  
Total area: 240 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 35 feet.

Group 5.  
Building No. 8.  
Occupancy: Toilets.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood purlins.	0	100	Blast and fire	Demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood	100	0	do	Do.
First floor: Concrete on earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: 8-inch concrete 2 feet high above floor, wood above.	0	100	Blast and fire	Wood parts demolished, concrete base still in place.
Interior walls: Wood	0	100	do	
Contents: Toilets	0	100	do	

# DAMAGE ANALYSIS

Dimensions: 78 by 10 feet.  
Ground floor area: 780 square feet.  
Total area: 780 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 35 feet.

Group 5.  
Building No. 9.  
Occupancy: Storage.  
Building type: Open wooden shed (D).  
Fire classification: C.  
Ground zero: 3,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood purlins.	0	100	Blast	Demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood, 4 by 4 inches	100	0	do	Do.
First floor: Concrete on earth	0	0		
Contents: Unknown	0	0		

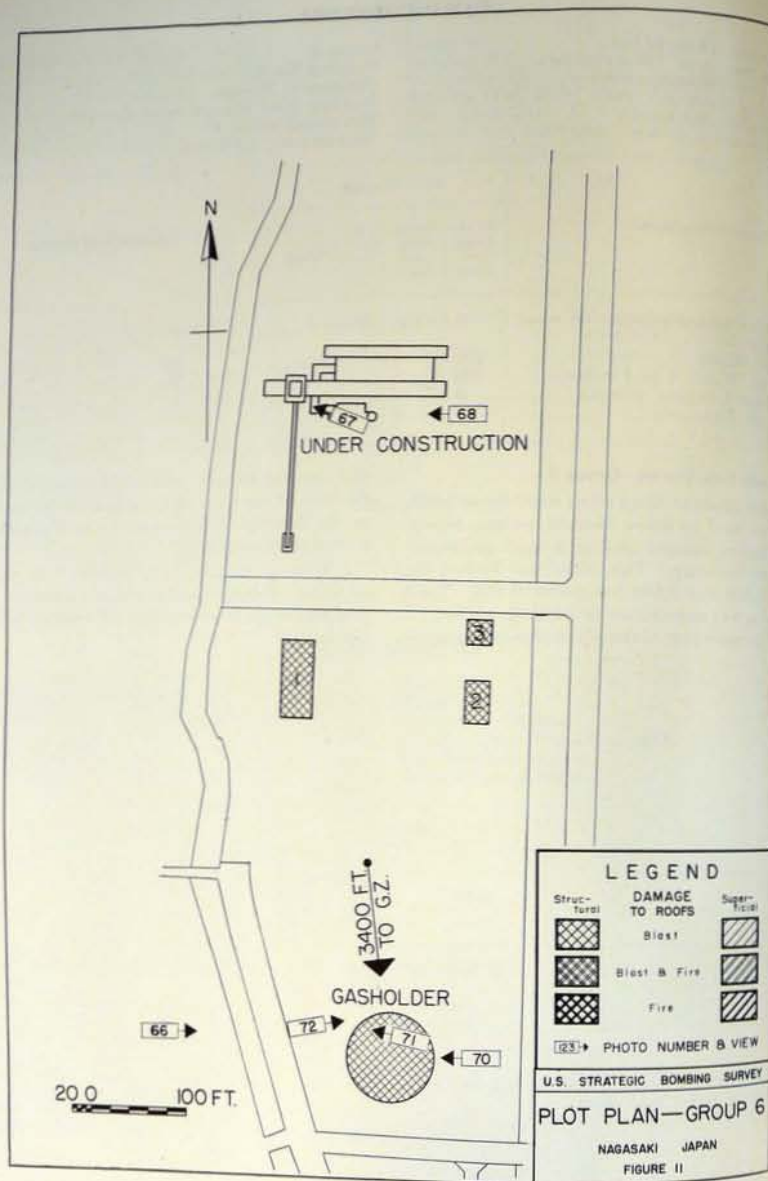
# 7. Ohashi Gas Works—Group 6.

a. This group of three small wood-frame buildings was used to house blowers, pumps, piping, and other equipment used in a small gas manufacturing industry. This plant was located between 3,500 and 3,600 feet north of GZ. Total plan area was approximately 3,400 square feet.

b. The main part of this plant (the coking ovens

and the coal hopper) was under construction at the time of the blast and the analysis of damage to the facilities will be covered in the utilities section of this report.

c. Damage to this group is shown on photos 66 to 74. Damage analysis sheets following the plot plan (Fig. 11) give further information regarding damage.

**DAMAGE ANALYSIS**

Dimensions: 61 by 29 feet.  
 Ground floor area: 1,770 square feet.  
 Total area: 1,770 square feet.  
 Number of floors: 1.  
 Eave height: Not known.  
 Mean elevation: 10 feet.

Group 6.  
 Building No. 1.  
 Occupancy: Pump or blower house.  
 Building type: Wood-frame (D).  
 Fire classification: C.  
 Ground zero: 3,500 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Wood and tile	0	100	Blast and fire	
Trusses: Wood	100	0	do.	
Columns: Wood	100	0	do.	
First floor: Concrete	0	0		
Foundation: 6-inch reinforced concrete.	40	0	Blast and fire	
Exterior walls: Wood	0	100	do.	
Windows: Wood sash	0	100	do.	
Contents: Blowers, compressors, and pumps.	30	0	Blast and debris	

Remarks: Superstructure blown north.

**DAMAGE ANALYSIS**

Dimensions: 23 by 35 feet.  
 Ground floor area: 800 square feet.  
 Total area: 800 square feet.  
 Number of floors: 1.  
 Eave height: Not known.  
 Mean elevation: 10 feet.

Group 6.  
 Building No. 2.  
 Occupancy: Pump house and regulator building.  
 Building type: Wood-frame (D).  
 Fire classification: C.  
 Ground zero: 3,500 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Wood and tile	0	100	Blast	
Trusses: Wood	100	0	do.	
Columns: Wood	100	0	do.	
First floor: Concrete on earth	0	0	do.	
Foundation: Concrete	40	0	do.	
Exterior Walls: Wood	0	100	do.	
Windows: Wood sash	0	100	do.	
Contents: Pumps and regulators	30	0	do.	

Remarks: Superstructure blown north.

# DAMAGE ANALYSIS

Dimensions: 30 by 27 feet.  
Ground floor area: 810 square feet.  
Total area: 810 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 6.  
Building No. 3.  
Occupancy: Office.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 3,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood	0	100	Blast	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete on earth	60	0	do	
Foundation: Concrete	60	0	do	
Exterior walls: Wood	0	10	do	
Windows: Wood sash	0	100	do	

Remarks: Building blown north.

## 8. Area West of Railroad and Highway in Fork of Urakami River—Group 12.

a. This was an irregularly shaped area about 3,000 feet long (north-south) by 750 feet wide (east-west), located approximately 350 feet west of the GZ. The most distant point in the area is 1,750 feet from GZ. The area contained a large number of buildings (industrial, commercial, and residential) which were generally small and unimportant structurally.

b. Devastation from blast and fire was so complete that little determination of details was possible; considerable clearing of debris had already been done prior to the dates of survey in Nagasaki. Figure 12 and Photos 75 to 81 present such data as could be recorded. The cause of the fires was considered to be primary.

c. The following notes explain the correspondingly lettered references in Figure 12:

A. Brick plant. Three brick kilns standing with badly cracked 34-inch brick walls, reinforced by vertical steel rails on outside, bearing heavy brick vaulted roofs 10 feet high which were destroyed by blast and fire. One small brick furnace or kiln with 12-inch walls open toward the north suffered little damage. One small steel-frame building which was wrecked.

B. Concrete stack, 4 feet diameter, 70 feet high; fell northwest.

C. A long narrow building completely destroyed by fire except for its foundations of light concrete.

D. A wood- and steel-frame building on concrete basement. Superstructure collapsed away from GZ and burned. Basement walls were damaged but remained standing. There was evidence of fire in the basement although it was not directly exposed.

E. One-story, reinforced-concrete building collapsed away from GZ. Steel roof trusses 100 percent damaged by blast.

F. Street car terminal and several small wood buildings. All burned.

G. Fair sized one-story machine shop completely destroyed by fire except for machines and foundations. Practically no framing debris left.

H. Lot of small wood debris, unburned.

I. Very large logs almost completely burned.

J. Machine shop demolished and burned.

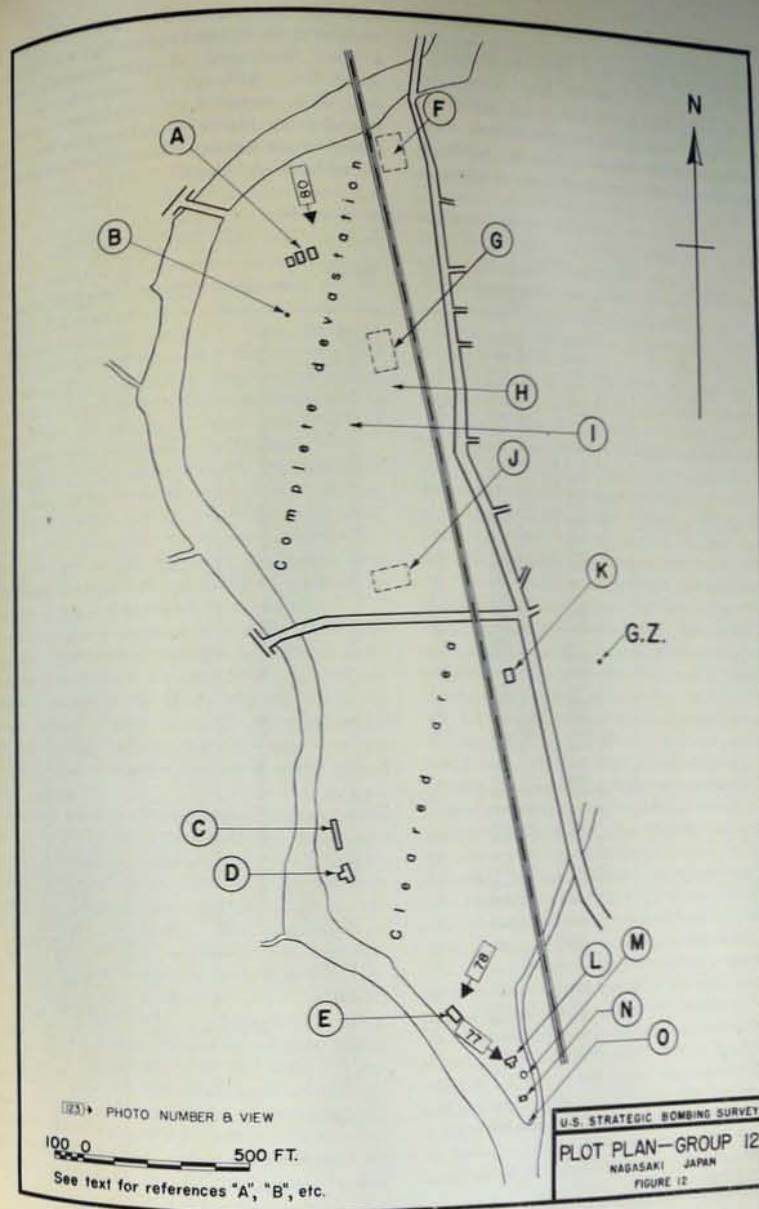
K. Concrete bathhouse demolished.

L. Small building with 12-inch brick load-bearing walls and concrete beams; possibly two stories. Completely wrecked. No evidence of fire.

M. Steel tank knocked off concrete foundation.

N. Small wood toilet building; collapsed; no fire.

O. Wood ashes near extreme tip of area.



# 9. Mitsubishi Steel and Arms Plant—Group 26.

a. This was a group of 47 buildings located on the east bank of the Urakami River almost due south of GZ. The north and south boundaries were 1,500 feet and 4,700 feet, respectively, from GZ. The buildings housed equipment and facilities for the manufacture of all types of ordnance

and steel ship parts. The total plan area was approximately 787,000 square feet and there was a total floor area of approximately 885,000 square feet. Although the major portion of the plan area consisted of steel-frame buildings, several other types of construction were represented in the group. These types are shown in the table which follows:

Building classification—Group 26

Building No.	Area		Type	Fire class	Construction			
	Plan (square feet)	Total (square feet)			Steel frame	Reinforced concrete	Concrete and steel	Wood
1.	4,500	6,000	D	C&N	X			X
2.	16,000	16,000	B2	N	X			
3.	36,480	36,480	B2	N	X			
4.	42,240	42,240	B2	N	X			
5.	13,100	13,100	A2.3	C	X			X
6.	10,000	10,000	B2	N	X			
7.	33,000	33,000	B2	N	X			
8.	11,484	11,484	B2	N	X			
9.	15,312	15,312	B2	N	X			
10A	4,640	4,640	D	N	X			
10B	13,770	13,770	A2.3	N	X			
11A	17,550	17,550	B1	N	X			
11B	11,700	11,700	B2	N	X			
11C	19,500	19,500	B1	N	X			
12A	7,800	7,800	D	N	X			
12B	768	768	D	R		X		
13.	9,750	9,750	D	N	X			
14.	6,156	18,468	E1	R		X		
15.	62,000	62,000	B2	N	X			
16.	9,000	9,000	D	N	X			
17.	4,000	8,000	S	N	X			
18.	4,500	4,500	D	N	X			
19.	31,000	31,000	B1	N	X			
20.	4,500	9,000	E1	R		X		
21.	1,000	1,000	D	R		X		
22.	10,500	10,500	B2	N	X			
23.	88,800	88,800	B1	N	X			
24.	4,500	4,500	D	N			X	
25A	1,800	1,800	B2	N	X			
25B	1,100	1,100	D	N	X			
26.	49,600	99,700	E2	R&N	X			
27.	5,050	22,000	E2	R	X			
28.	5,400	10,800	E1	R	X			
29.	68,500	68,500	B2	R	X			
30.	25,000	25,000	B2	R	X			
31.	23,000	23,000	E1	R	X			
32.	1,900	1,900	D	N	X			
33.	1,400	1,400	D				X	
34.	6,400	10,000	D	R		X		
35.	1,200	1,200	D	C				X
36.	(?)	(?)	D	D				X
37.								
38.								
39.	5,625	5,625	D	C&R		X		X
40.	600	600	D	C				X
41.	78,408	78,408	A2.3	N	X			X
42.	9,000	9,000	D	C				X
43.	9,000	9,000	D	C				X
44.								
45.	(?)							
46.								
Totals <sup>1</sup>	786,533	884,895			26	11	2	

<sup>1</sup> Part.

<sup>2</sup> Unknown.

<sup>3</sup> Storage yard.

<sup>4</sup> Storage yard.

<sup>5</sup> In addition, 2 buildings, each partly steel frame and partly wood.

b. Every building in this group suffered some damage. The degree of damage varied from total damage to minor damage to parapet walls, interior walls, and windows.

c. The 28 steel-frame buildings were of open steel construction similar to that of steel mill buildings in the United States. Walls and roofs were of corrugated iron. The main and secondary columns were built-up, latticed members, and roof trusses were light. Column foundations were generally individual concrete piers, and the crane supports were of either girder or truss design. The horizontal and lateral bracings were not unusual for this type of plant. Most of the damage to these buildings was caused by blast; the buildings themselves and most of their contents were noncombustible. There were many notable examples of structural failures in main members and foundations. In nearly all cases, the light steel roof trusses were vulnerable to the blast.

d. Building 1, housing a foundry, was two-thirds steel frame and one-third wood frame. Its roof was covered with corrugated asbestos on wood joists. The entire structure was demolished by blast and fire which probably originated from open-flame devices and consumed all combustible portions of the building and its contents.

e. Building 2, a foundry, was a large mill-type structure, steel-frame throughout with a corrugated iron roof and a concrete floor. It was considerably damaged by blast, and the steel also showed some effects of fire. All combustible material in the building was consumed by the fire which was probably the result of fire spread from Building 1.

f. A very small fire which caused only negligible damage occurred in a motor-driven compressor (one of a pair) at the extreme north end of Building 3 which was itself noncombustible and therefore suffered no damage from fire (although it was badly damaged by blast). The multiple Vee-type belt drive of the compressor was, however, destroyed, as were some flexible rubber hose connections and electric wiring and control gear. It was noted that there was a leakage of oil from the machine to the ground, which could have caused fire spread to the belting, hose, and leads. It was improbable that an electrical fault could have caused the fire. Although the main leads from the ground had apparently been broken off when blast blew in the north end of the building, they showed no trace of fire at this point. It was

concluded, therefore, that the fire was started by a flying ember from a small building which was located just to the north and was completely destroyed by blast and fire.

g. A specific example of a steel-frame building which withstood the blast was Building 19 (Figs. 18, 19) which was located 3,900 feet from GZ with its long axis parallel to the direction of the blast. It housed a 4,000-ton steel press, and its columns, bracings, crane supports, and foundation were designed to carry a 70-ton crane and a 180-ton crane, the tracks for which were about 55 feet above the floor level. The building suffered very little damage other than the loss of the corrugated-iron roof and wall siding (Photos 122, 126, 127, 128, 130, and 131).

h. The damage in Building 19 may be compared with that in Building 23 which failed under the blast. The latter was a heavy steel-frame structure located 4,100 feet from GZ with its long axis at right angles to the direction of the blast. The examples of structural failure in this building were many and varied. Heavy (weight 340 pounds per foot) latticed columns buckled, foundation were uprooted, and crane girders were tilted on their supports. A small fire occurred in this building, probably due to an overturned brazier which ignited a wooden bench, but it failed to spread, due to the noncombustible nature of the building and its contents, so that the resulting fire damage was negligible.

i. Building 26 offered some interesting examples of damage by fire and blast. It was a two-story, steel-frame structure with a row of heavy steel columns in the center, which carried heavy built-up girders which, in turn, supported the reinforced-concrete second floor. The building had a monitor roof covered with asphalt laid on felting supported by wood boards. The exterior walls were of brick for the first 4 feet above the ground and the remainder was of glass and corrugated-metal sheeting. The first floor was used for a heavy machine shop and for torpedo assembly, while the second floor was used for hand finishing and storage of partly assembled torpedoes.

j. The explosion of the atomic bomb caused several of the columns center row to buckle and collapse. This brought about the collapse of the roof and second floor; and their collapse, in turn, dragged the side and end framework of the building inward. All of this was considered to have been caused by blast. Although a fire occurred

in the building the nature of the bent columns indicated that the steel had not been subjected to much heat. The roof covering and timber purlins were entirely consumed by fire which burned on top of the reinforced-concrete floor. The only sign of fire on the first floor was the ignition of material by burning wood which fell from the second floor. The fires on the first floor were purely local as it was noted that wood benches and racks distributed about the first floor were untouched by fire. The cause of the fire was probably secondary, although the collapse of the floor prevented thorough examination of the contents to locate appliances which could have started the fire. The generally noncombustible nature of the building's construction and contents was not conducive to primary fire, and conflagration from exposure was not possible.

k. The 11 reinforced-concrete buildings in the group can be divided into two types: (1) multi-story office buildings of beam-and-girder design (Building 19); and (2) the single-story, arch-roof design (Building 29).

(1) Building 14, Figure 14, located 3,500 feet from GZ, was a three-story office building of construction similar to that used in the United States. The structural damage suffered was all due to blast, and consisted of the failure of a 3-foot parapet wall and the cracking of three roof beams (Photos 118, 119).

(2) The best example of a single-story, arched-roof, reinforced-concrete structure was Building 29, located 4,600 feet from GZ. This was a multiarch building, three bays wide. Many types of failures were observed as more than half

of the building collapsed from the blast. The roof, falling inside the building, caused supporting columns and walls to fall in opposite directions. In this action, columns and walls were fractured and footings and foundations were uprooted. It is possible that some of the other failures such as wall, column, and girder cracks were caused by the fall of this heavy mass of concrete (Photos 144, 145, 148, 149, 151, 152, 153).

l. One instance of rather unusual reinforced-concrete construction was found in building 30. The walls of this structure were reinforced with bamboo, and collapsed because of blast. The wood roof was consumed by fire.

m. Two examples of mixed steel-and-concrete construction were found in the group. An excellent example of this composite type of structure was Building 27 (Fig. 22), located 4,500 feet from GZ. This was a five-story office building with heavy concrete walls and heavy steel column girders, and beams. The only part of the structure not classified as heavy construction was the roof, which was of thin concrete supported by unusually light steel trusses. The downward failure of this roof was the only structural damage in the building (Photos 142, 143).

n. Fire protection for the group was provided by the public water supply and yard mains and hydrants. In addition, there were several small mobile, motor-driven pumps, a few small static tanks, and hand-operated pumps and fire extinguishers, all operated by a private fire brigade.

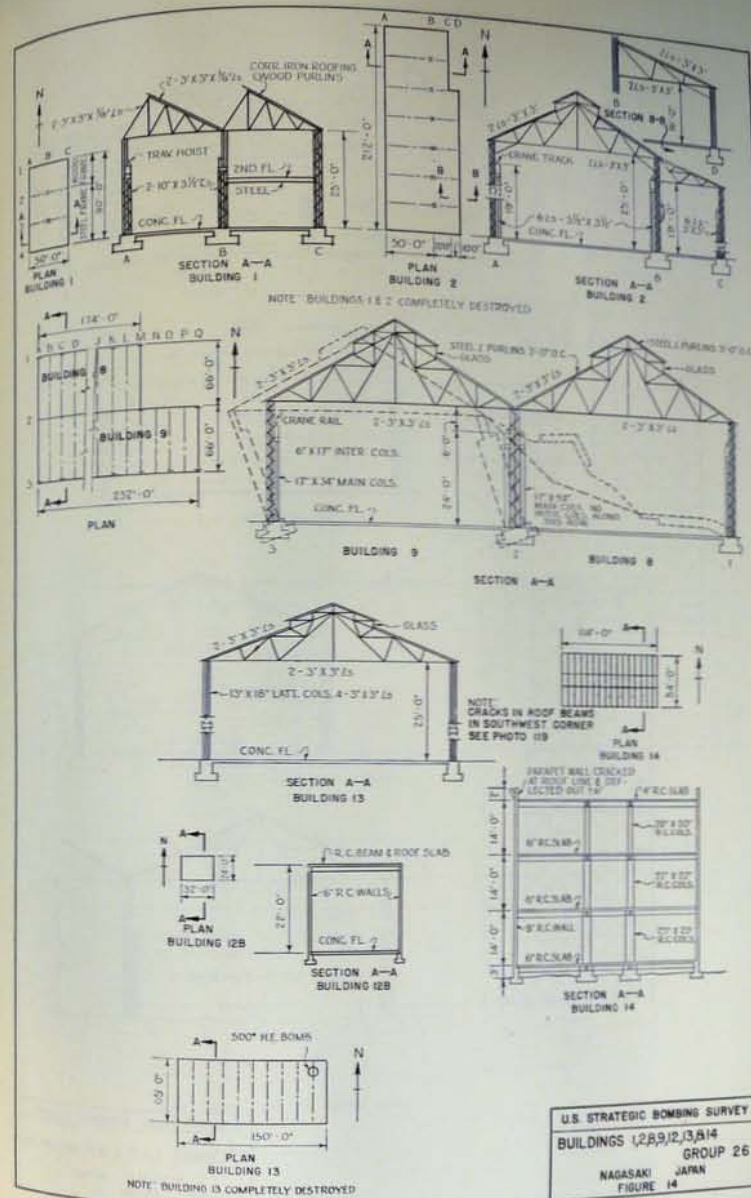
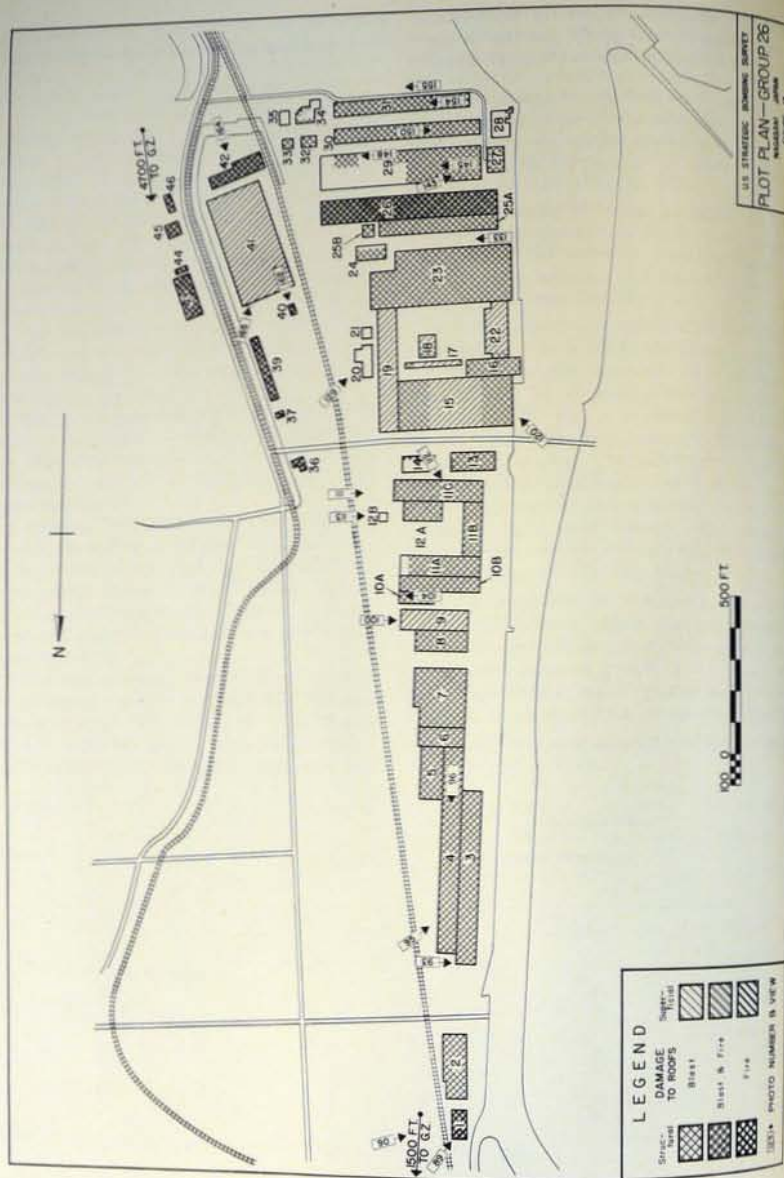
The following is a summary of fire damage to buildings and contents:

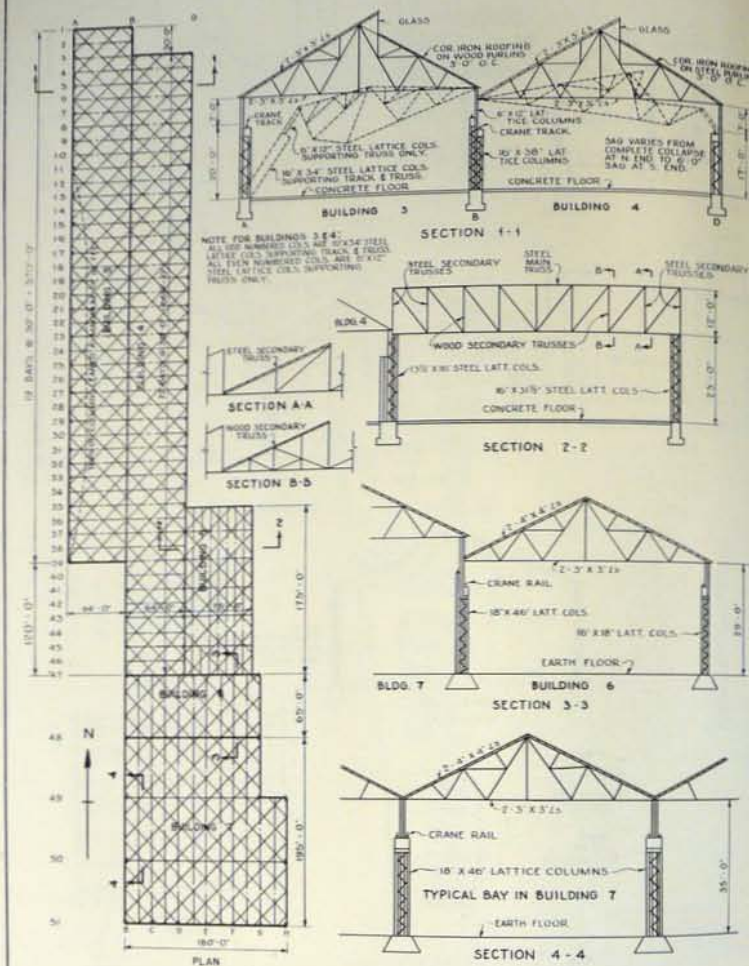
Building No.	Occupancy	Class	Estimated damage*		
			Blast and fire, buildings		Fire contents
			Structural	Superficial	
1.	Foundry	C-1 $\frac{1}{2}$ N-1 $\frac{1}{2}$	Serious	Serious	Serious
2.	do.	N	do.	do.	Moderate
3.	Heavy machine shop	N	None	None	Slight
23.	do.	N	do.	do.	Nominal
26.	Machine shop	C-Roof	Moderate	Serious	Moderate
36.	Torpedo assembly	N-Bal			
37.	Probably storage	C	Total	Total	Total
39.	do.	C	do.	do.	Do.
42.	do.	C-Roof	do.	do.	Do.
43.	do.	N-Bal	do.	do.	Do.
	do.	C	do.	do.	Do.
	do.	C	do.	do.	Do.

\*Total—100 percent; serious—above 50 percent; moderate—25 to 50 percent; slight—below 25 percent.

p. Further information about the construction of the buildings in this group and the damage suffered by them will be found in Photos 82 through

166, in Figures 13 through 24, and in the damage-analysis sheets immediately following the figure.

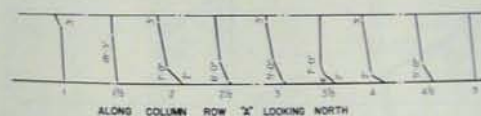
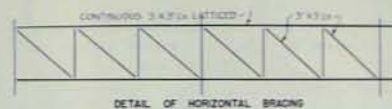
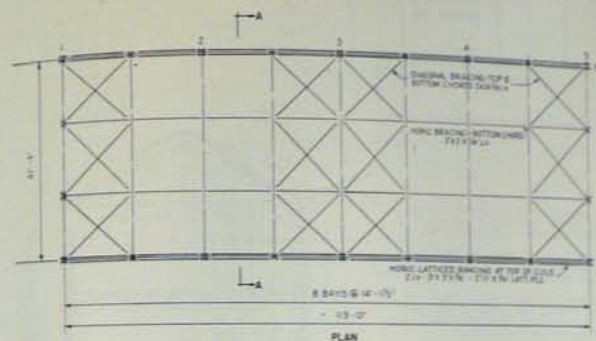
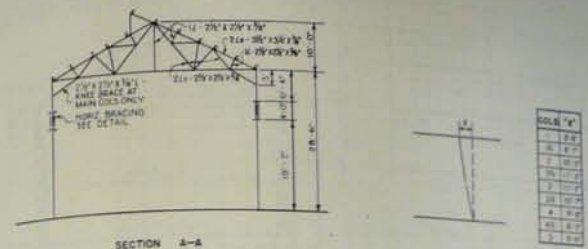




U.S. STRATEGIC BOMBING SURVEY

BUILDINGS 3,4,5,6,7 GROUP 26

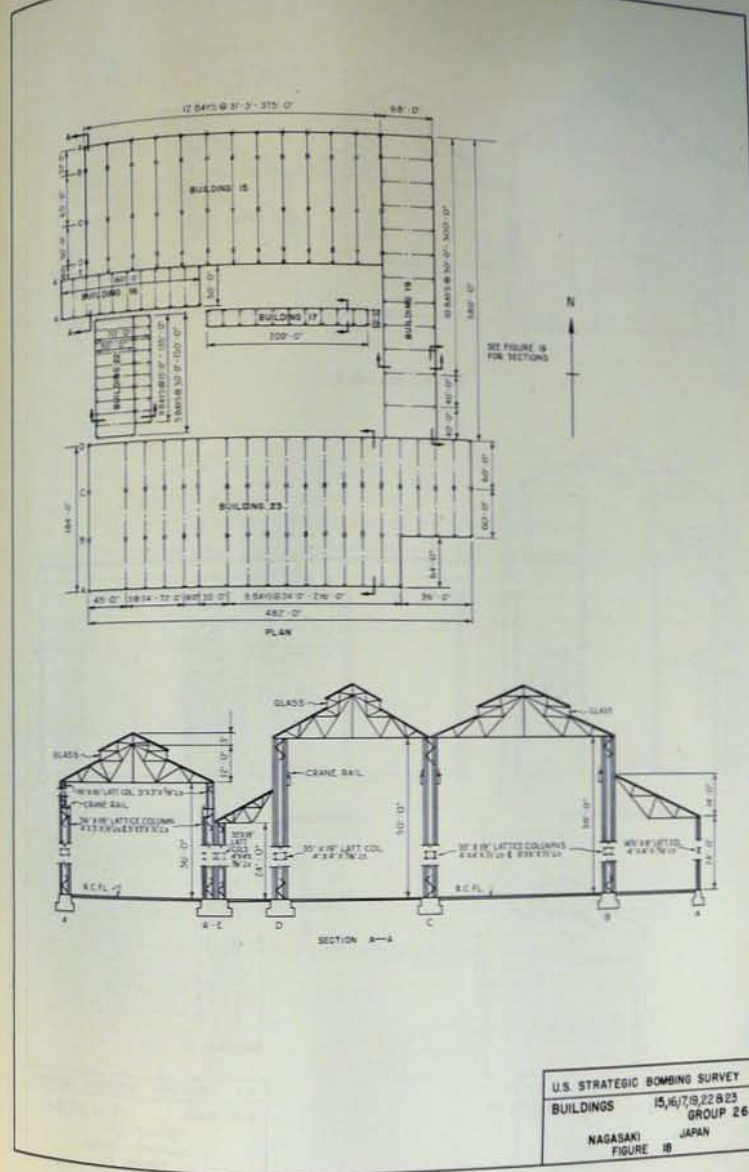
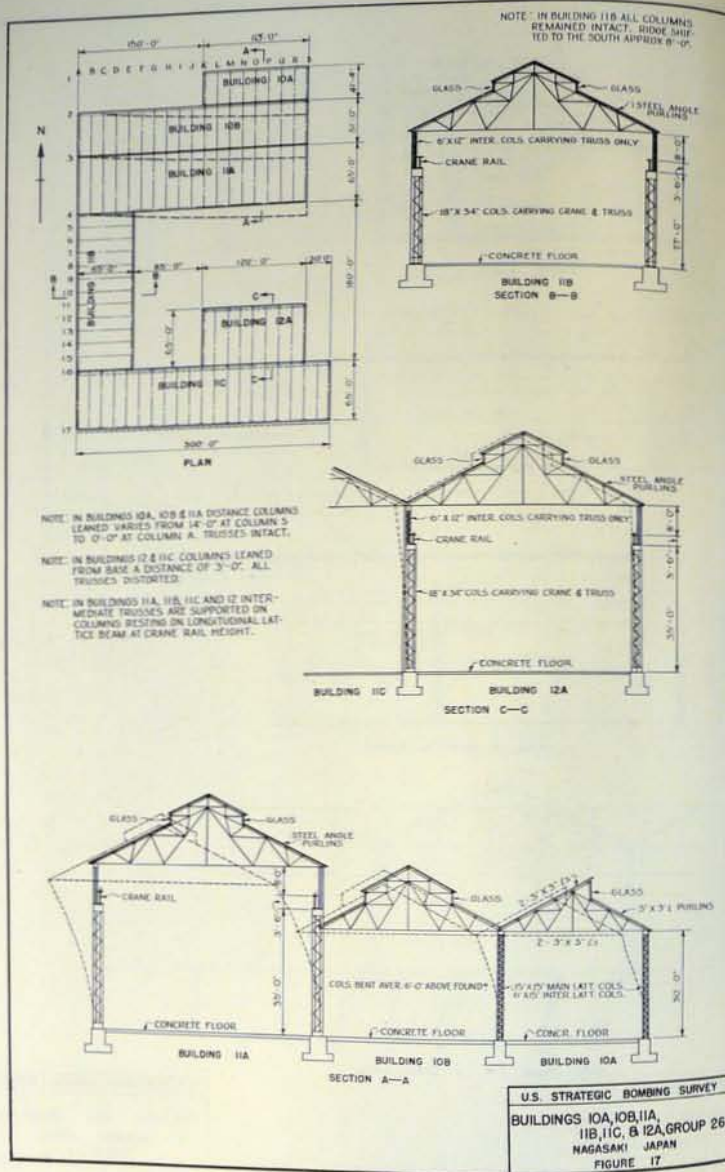
NAGASAKI JAPAN  
FIGURE 15

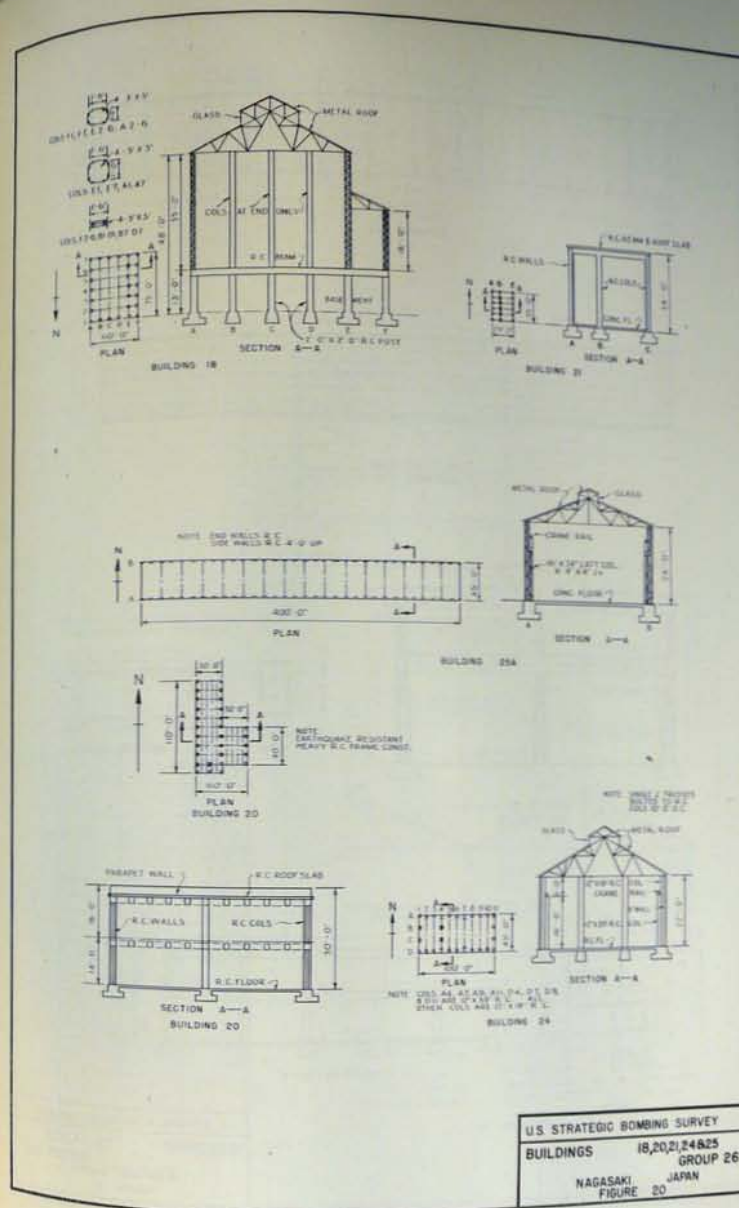
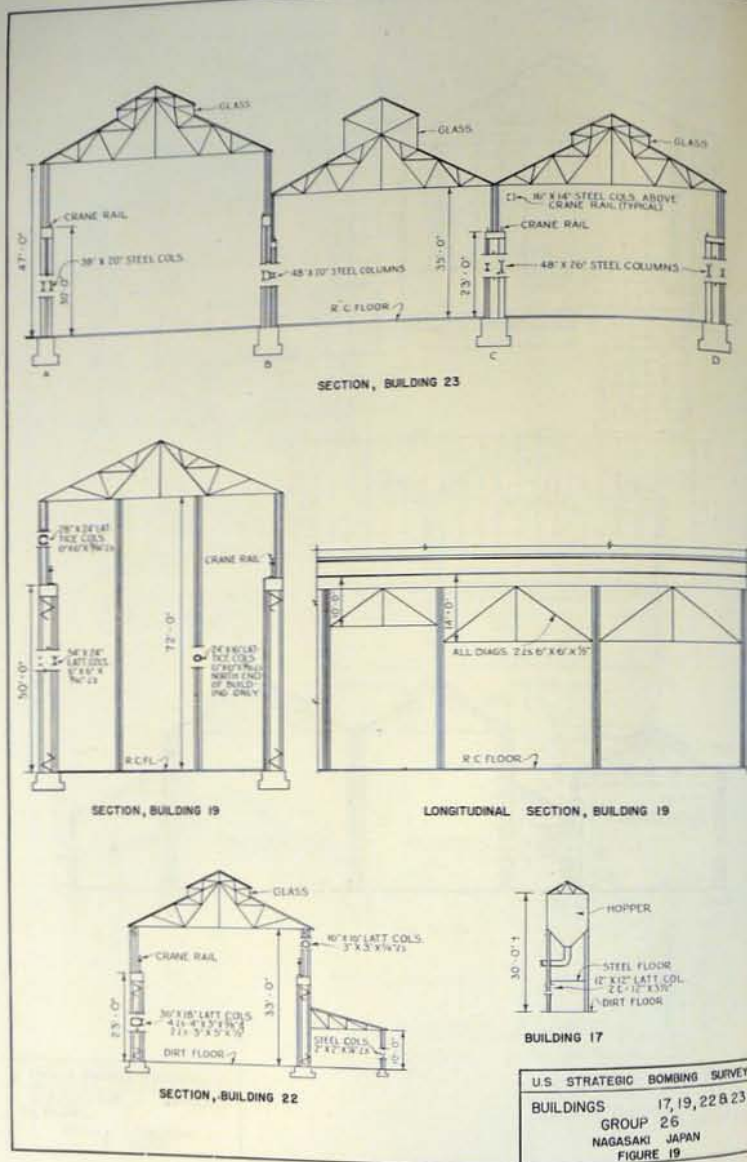


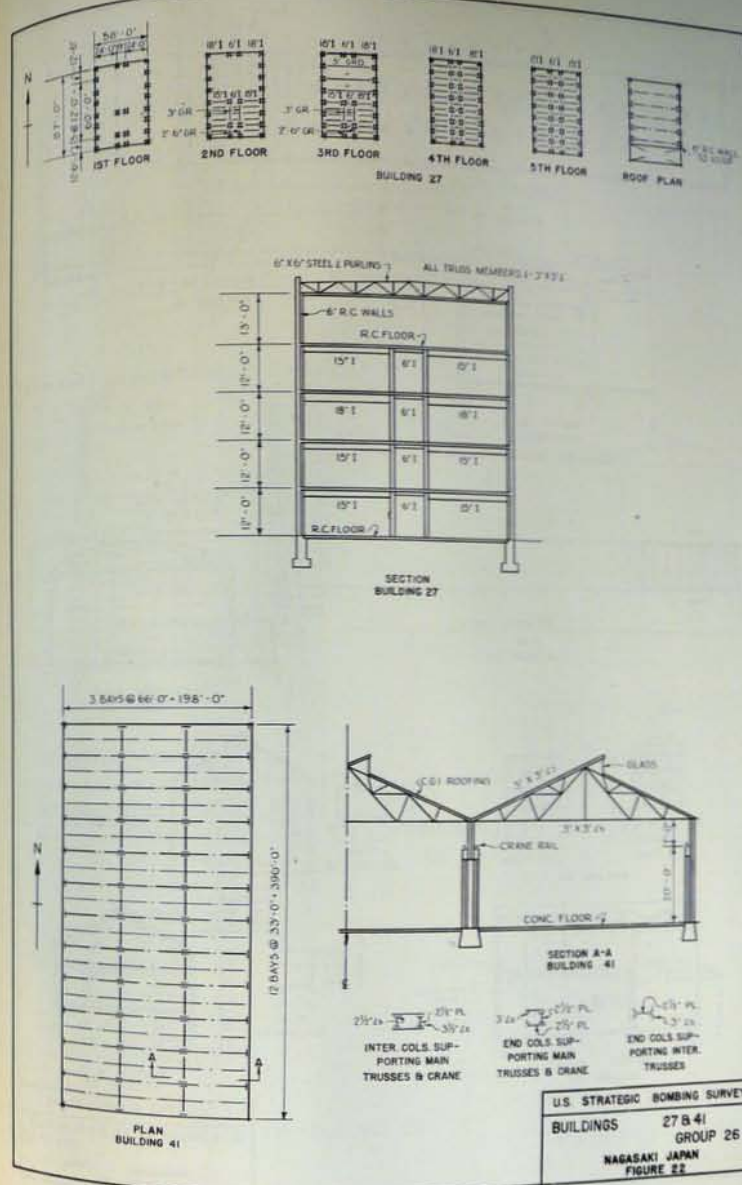
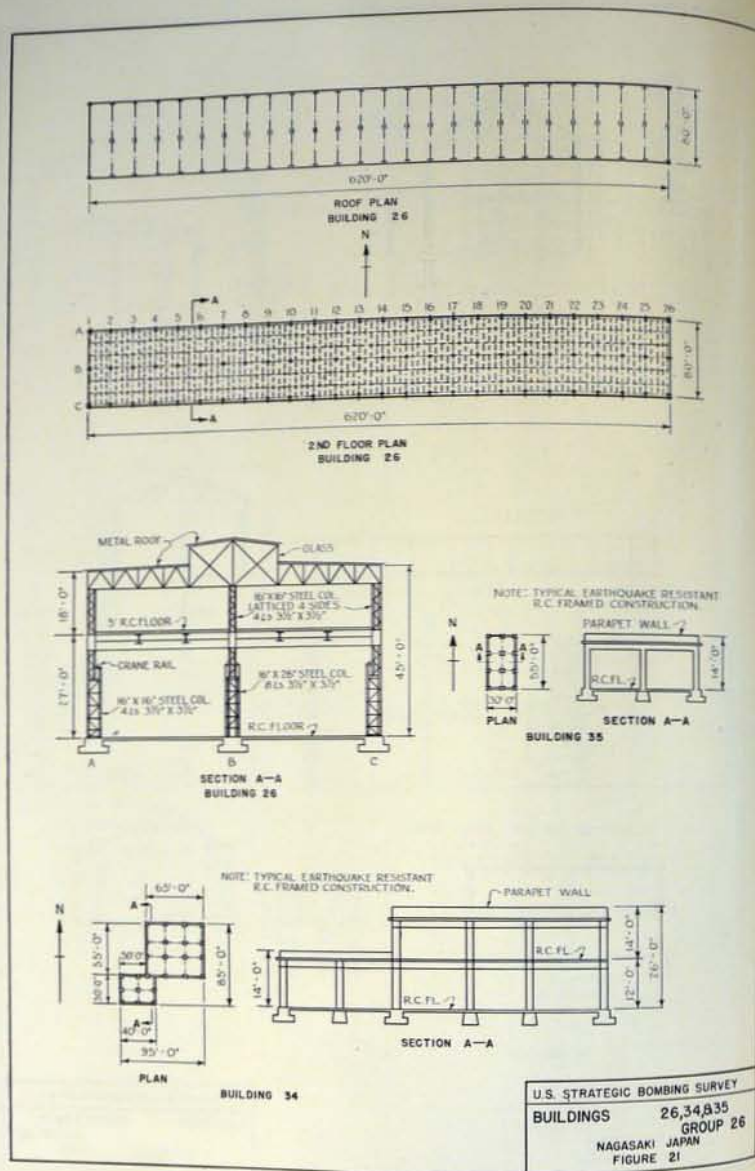
U.S. STRATEGIC BOMBING SURVEY

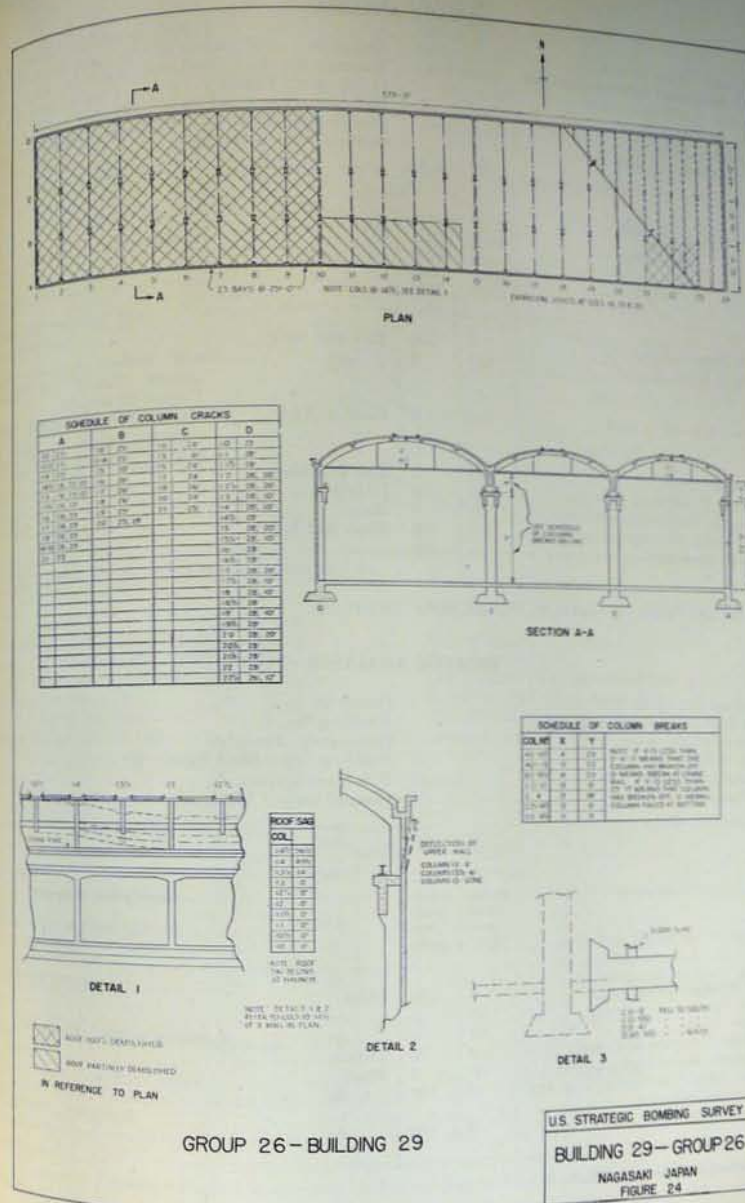
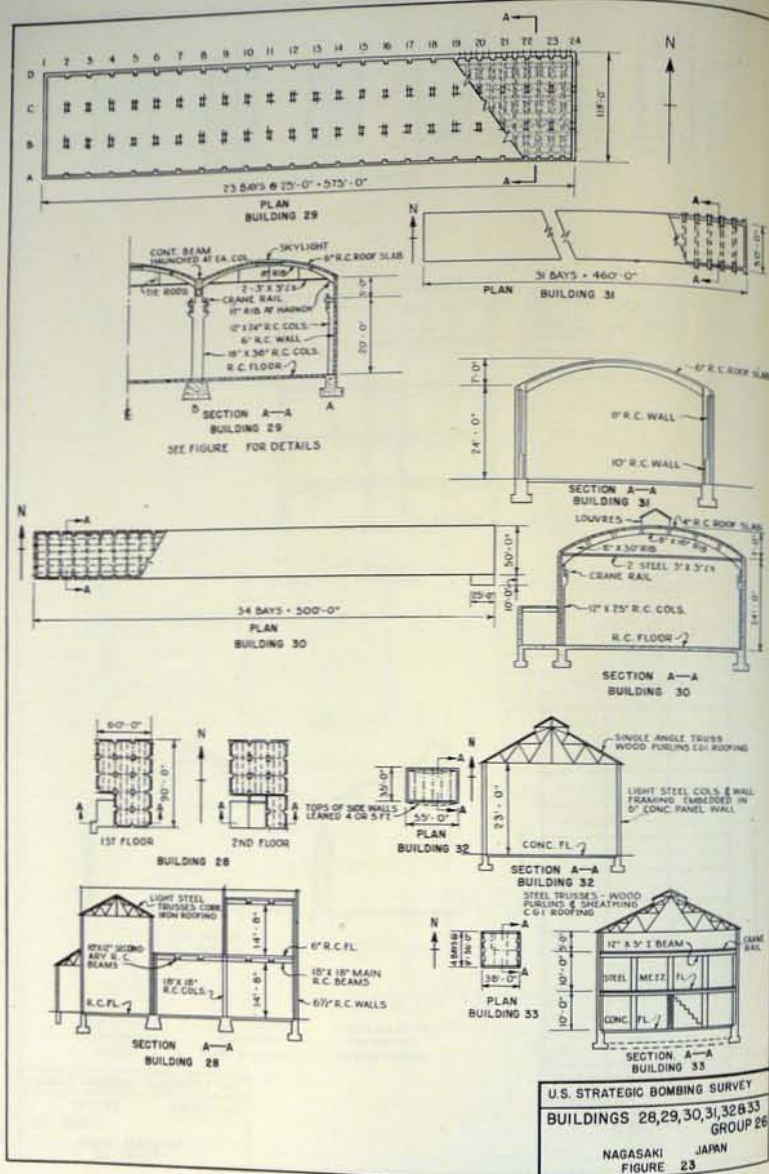
BUILDING 10A GROUP 25

NAGASAKI JAPAN  
FIGURE 16









# DAMAGE ANALYSIS

Dimensions: 90 by 50 feet.  
Ground floor area: 4,500 square feet.  
Total area: 6,000 square feet.  
Number of floors: 2.  
Eave height: 25 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 1.  
Occupancy: Foundry.  
Building type: Steel frame (D).  
Fire classification: C  $\frac{1}{2}$ , N  $\frac{3}{4}$ .  
Ground zero: 1,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Fire and blast	Wood trusses burned; steel trusses failed by blast. Photos 89 and 90.
Trusses: $\frac{1}{2}$ wood, $\frac{1}{2}$ steel	100	0	do	
Columns: $\frac{1}{2}$ wood, $\frac{1}{2}$ steel	100	0	Blast and fire	Wood columns burned; steel columns failed by blast to south. Photos 89 and 90.
Second floor: Steel	100	0	Fire and blast	Debris
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	30	0	Blast	
Exterior walls: Corrugated iron	0	100	Blast and fire	
Windows: Steel sash	0	100		

Remarks: Figure 14; Photos 88, 89, and 90.

# DAMAGE ANALYSIS

Dimensions: 212 by 80 feet.  
Ground floor area: 16,000 square feet.  
Total area: 16,000 square feet.  
Number of floors: 1.  
Eave height: 37 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 2.  
Occupancy: Foundry.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 1,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Leaning south. Photo 91.
Trusses: Steel	50	0	do	
Columns: Steel	50	0	do	
First floor: Concrete and earth	0	10	Debris	
Foundation: Reinforced concrete	50	0	Blast	
Exterior walls: Corrugated iron and corrugated asbestos	0	100	do	
Windows: Steel sash	0	100	do	

Remarks: Figure 14; Photo 91.

# DAMAGE ANALYSIS

Dimensions: 570 by 64 feet.  
Ground floor area: 36,480 square feet.  
Total area: 36,480 square feet.  
Number of floors: 1.  
Eave height: 27 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 3.  
Occupancy: Heavy lathe and milling machinery.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 1,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Failed downward—pulled west wall inward. Photo 92.
Trusses: Steel	100	0	do	
Columns: Steel	40	0	do	
First floor: Concrete on earth 5-6 inches	0	0		Photo 93.
Foundation: Concrete piers	50	0	Blast	
Exterior walls: Corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Crane, lathes, milling machines	0	40	Weather	

Remarks: Figure 15; Photos 92, 93, and 94.

# DAMAGE ANALYSIS

Dimensions: 660 by 64 feet.  
Ground floor area: 42,240 square feet.  
Total area: 42,240 square feet.  
Number of floors: 1.  
Eave height: 24 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 4.  
Occupancy: Heat treatment and large lathes.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 1,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Trusses thrust downward. Photo 95.
Trusses: Steel	100	0	do	
Columns: Steel	30	0	do	
First floor: Concrete 5-6 inches on earth	0	0		Uprooted.
Foundation: Concrete piers	30	0	Blast	
Exterior walls: Corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Heat treatment furnaces	0	20	do	

Remarks: Trusses collapsed downward—100 percent at north end; varies at south end. Figure 15; Photos 95 and 96.

# DAMAGE ANALYSIS

Dimensions: 175 by 75 feet.  
Ground floor area: 13,100 square feet.  
Total area: 13,100 square feet.  
Number of floors: 1.  
Eave height: 23 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 5.  
Occupancy: Not known.  
Building type: Steel and wood (A2.3).  
Fire classification: C.  
Ground zero: 1,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Photo 97.
Trusses: Steel and wood	100	0	do.	
Columns: Steel	100	0	do.	
First floor: Reinforced concrete	0	0	Blast	Uprooted.
Foundation: Reinforced concrete	80	0		
Exterior walls: Corrugated iron	0	100		
Windows: Steel sash	0	100	do.	
Contents: Not known	0	0		

Remarks: Building collapsed toward south. Figure 15; Photo 97.

# DAMAGE ANALYSIS

Dimensions: 150 by 65 feet.  
Ground floor area: 10,000 square feet.  
Total area: 10,000 square feet.  
Number of floors: 1.  
Eave height: 45 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 6.  
Occupancy: Not known.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 1,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Collapsed. Failed to south. Photo 98.
Trusses: Steel	100	0	do.	
Columns: Steel	100	0	do.	
First floor: Earth	0	0	Blast. Uprooted.	
Foundation: Reinforced concrete	90	0		
Exterior walls: Corrugated iron	0	100		
Windows: Steel sash	0	100	do.	
Contents: Crane	20	0	Debris and blast.	

Remarks: Figure 15; Photo 98.

# DAMAGE ANALYSIS

Dimensions: 180 by 195 feet.  
Ground floor area: 33,000 square feet.  
Total area: 33,000 square feet.  
Number of floors: 1.  
Eave height: 51 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 7.  
Occupancy: Not known.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 1,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Collapsed. Leaned southwesterly. Photos 99 and 101.
Trusses: Steel	100	0	do.	
Columns: Steel	100	0	do.	
First floor: Earth	0	0	Blast	Uprooted.
Foundation: Reinforced concrete	90	0		
Exterior walls: Corrugated iron	0	100		
Windows: Steel sash	0	100	do.	
Contents: Cranes	100	0	Blast and debris	

Remarks: Building collapsed in a southwesterly direction. Figure 15; Photos 99 and 101.

# DAMAGE ANALYSIS

Dimensions: 174 by 66 feet.  
Ground floor area: 11,484 square feet.  
Total area: 11,484 square feet.  
Number of floors: 1.  
Eave height: 30 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 8.  
Occupancy: Foundry.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 2,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	All columns on north side destroyed; collapsed to south.
Trusses: Steel	100	0	do.	
Columns: Steel	50	0	do.	
First floor: Concrete 5-6 inch on earth	0	0	Blast	Piers tilted.
Foundation: Concrete piers 2 by 2 by 6 feet	25	0		
Exterior walls: Corrugated iron	0	100		
Windows: Steel sash	0	100	do.	
Contents: Large furnaces	10	0	Weather	

Remarks: Figure 14.

# DAMAGE ANALYSIS

Dimensions: 232 by 66 feet.  
Ground floor area: 15,312 square feet.  
Total area: 15,312 square feet.  
Number of floors: 1.  
Eave height: 30 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 9.  
Occupancy: Foundry.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 2,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Columns leaning south. Photos 100, 102.
Trusses: Steel	0	40	do	
Columns: Steel	0	100	do	
First floor: Concrete 5-6 inches on earth.	0	0		
Foundation: Concrete piers 2 by 2 by 6 feet.	100	0	Blast	
Exterior walls: Corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Cranes and machine tools.	0	100	Weather	

Remarks: Figure 14; Photos 100 and 102.

# DAMAGE ANALYSIS

Dimensions: 113 by 41 feet.  
Ground floor area: 4,640 square feet.  
Total area: 4,640 square feet.  
Number of floors: 1.  
Eave height: 28 feet 6 inches.  
Mean elevation: 10 feet.

Group 26.  
Building No. 10A.  
Occupancy: Not known.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 2,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	All columns structurally damaged. Building leans to south. Photos 103 through 107.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Concrete on earth	0	0		
Foundation: Reinforced concrete	10	0	Blast	Uprooted
Exterior walls: Corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	
	0	100	do	

Remarks: Figures 16 and 17; Photos 103 through 107.

# DAMAGE ANALYSIS

Dimensions: 270 by 51 feet.  
Ground floor area: 13,770 square feet.  
Total area: 13,770 square feet.  
Number of floors: 1.  
Eave height: 30 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 10B.  
Occupancy: Foundry.  
Building type: Steel frame (A2.3).  
Fire classification: N.  
Ground zero: 3,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Columns bent to south varying from 14 feet to 0.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: 5-6 inch concrete on earth.	0	0		
Foundation: Concrete piers	0	0		Broken at furnaces.
Exterior walls: Corrugated iron	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: Piping	0	75	do	

Remarks: Figure 17.

# DAMAGE ANALYSIS

Dimensions: 270 by 65 feet.  
Ground floor area: 17,550 square feet.  
Total area: 17,550 square feet.  
Number of floors: 1.  
Eave height: 47 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 11A.  
Occupancy: Forge-Shop.  
Building type: Steel frame (B1).  
Fire classification: N.  
Ground zero: 3,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	All trusses but one distorted. Columns failed to south. Photos 108, 109, and 110.
Trusses: Steel	90	0	do	
Columns: Steel	100	0	do	
First floor: 5-6 inches concrete on earth.	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Corrugated iron	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: 3 cranes	0	100	Weather	

Remarks: Figure 17; Photos 108, 109, and 110.

# DAMAGE ANALYSIS

Dimensions: 180 by 65 feet.  
Ground floor area: 11,700 square feet.  
Total area: 11,700 square feet.  
Number of floors: 1.  
Eave height: 38 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 11B.  
Occupancy: Storage—Castings.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 3,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron.....	0	100	Blast.....	Trusses lean south approximately 8 feet at top. No longitudinal bracing. Photo 116.
Trusses: Steel.....	100	0	do.....	
Columns: Steel.....	0	0	.....	
First floor: 5-6 inches concrete on earth.....	0	0	.....	
Foundation: Concrete piers.....	0	0	.....	
Exterior walls: Corrugated iron.....	0	100	.....	
Contents: 2 cranes.....	0	0	.....	

Remarks: Figure 17; Photo 116.

# DAMAGE ANALYSIS

Dimensions: 300 by 65 feet.  
Ground floor area: 19,500 square feet.  
Total area: 19,500 square feet.  
Number of floors: 1.  
Eave height: 47 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 11C.  
Occupancy: Foundry.  
Building type: Steel frame (B1).  
Fire classification: N.  
Ground zero: 3,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron.....	0	100	Blast.....	Distorted. Columns lean plus or minus 3 feet to south.
Trusses: Steel.....	100	0	do.....	
Columns: Steel.....	0	0	.....	
First floor: 5-6 inches concrete on earth.....	0	0	.....	
Foundation: Concrete piers.....	0	0	.....	
Exterior walls: Corrugated iron.....	0	100	Blast.....	
Windows: Steel sash.....	0	100	do.....	
Contents: 1,000-kilovolt-ampere transformer and switch gear.....	100	0	do.....	Blast wall blown against this equipment.

Remarks: Figure 17; Photos 111 and 112.

# DAMAGE ANALYSIS

Dimensions: 120 by 65 feet.  
Ground floor area: 7,800 square feet.  
Total area: 7,800 square feet.  
Number of floors: 1.  
Eave height: 47 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 12A.  
Occupancy: Furnaces for melting steel scrap.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 3,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron.....	0	100	Blast.....	Sag. Columns lean plus or minus 3 feet to south.
Trusses: Steel.....	100	0	do.....	
Columns: Steel.....	0	0	.....	
First floor: 5-6 inches concrete on earth.....	0	0	.....	
Foundation: Concrete piers.....	0	0	.....	
Exterior walls: Corrugated iron.....	0	100	.....	
Windows: Steel sash.....	0	100	.....	
Contents: Switch gear and 1,000-kilovolt-ampere transformer.....	100	0	Blast.....	Damaged by brick wall caving in.

Remarks: Figure 17.

# DAMAGE ANALYSIS

Dimensions: 32 by 24 feet.  
Ground floor area: 768 square feet.  
Total area: 768 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 12B.  
Occupancy: Transformer house and switch room.  
Building type: Concrete framing (D).  
Fire classification: R.  
Ground zero: 3,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete.....	0	0	.....	
Columns: Reinforced concrete.....	0	0	.....	
First floor: Reinforced concrete.....	0	0	.....	
Foundation: Reinforced concrete.....	0	0	.....	
Exterior walls: Reinforced concrete.....	0	0	.....	
Windows: Steel sash.....	0	100	.....	
Contents: 6 transformers, 9 oil circuit breakers.....	0	10	Weather.....	

Remarks: Wood plank and dirt blast walls—2 sides—south and west. Figure 14; Photos 113 and 117.

# DAMAGE ANALYSIS

Dimensions: 150 by 65 feet.  
Ground floor area: 9,750 square feet.  
Total area: 9,750 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 13.  
Occupancy: Pattern shop—small foundry.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 3,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron.....	0	100	Blast.....	Building completely collapsed to south. Photos 114 and 115.
Trusses: Steel.....	100	0	do.....	
Columns: Steel.....	100	0	do.....	
First floor: 5-6 inches concrete on earth.....	40	0	do.....	Overturned.
Foundation: Concrete piers 2 by 2 by 5 feet.....	40	0	do.....	
Exterior walls: Corrugated iron.....	0	100	do.....	
Windows: Steel sash.....	0	100	do.....	
Contents: Foundry equipment.....	25	0	do.....	

Remarks: Building received a 500-pound HE bomb, 8 Aug. 1945. Figure 14; Photos 114 and 115.

# DAMAGE ANALYSIS

Dimensions: 114 by 54 feet.  
Ground floor area: 6,156 square feet.  
Total area: 18,468 square feet.  
Number of floors: 3.  
Eave height: 47 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 14.  
Occupancy: Office.  
Building type: R. C. (E1).  
Fire classification: R.  
Ground zero: 3,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete.....	10	0	Blast.....	3-foot parapet and 3 roof beams cracked. Photos 118 and 119.
Columns: Reinforced concrete.....	0	0	.....	
Third floor: Reinforced concrete.....	0	0	.....	
Second floor: Reinforced concrete.....	0	0	.....	
First floor: Reinforced concrete.....	0	0	.....	
Basement: Reinforced concrete.....	0	0	.....	
Foundation: Reinforced concrete.....	0	0	.....	
Exterior walls: Reinforced concrete.....	0	0	.....	
Interior walls: Lath and plaster.....	0	100	Blast.....	do.....
Windows: Steel sash.....	0	100	do.....	
Finish: Plaster.....	0	20	do.....	

Remarks: Figure 14; Photos 118 and 119.

# DAMAGE ANALYSIS

Dimensions: 375 by 165 feet.  
Ground floor area: 62,000 square feet.  
Total area: 62,000 square feet.  
Number of floors: 1.  
Eave height: 50 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 15.  
Occupancy: Annealing and casting shop.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 3,700 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Corrugated iron	0	100	Blast	Building collapsed to south. Photo 120.
Trusses: Steel	50	0	do	
Columns: Steel	75	0	do	
First floor: Concrete	0	0	Debris	Derailed by building. Distortion.
Foundation: Spread footings	20	0	Blast	
Exterior walls: Corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Cranes	100	0	do	

Remarks: Plate crane girder collapsed; open crane truss O. K. Figure 18; Photo 120.

# DAMAGE ANALYSIS

Dimensions: 180 by 50 feet.  
Ground floor area: 9,000 square feet.  
Total area: 9,000 square feet.  
Number of floors: 1.  
Eave height: 51 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 16.  
Occupancy: Scrap metal building.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 3,900 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Corrugated iron	0	100	Blast	Leans to south. Photo 121.
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Earth	0	0	do	Uprooted.
Foundation: Concrete	30	0	Blast	
Exterior walls: Corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	Derailed and dropped.
Contents: Cranes	40	0	do	

Remarks: Figure 18; Photo 121.

# DAMAGE ANALYSIS

Dimensions: 200 by 20 feet.  
Ground floor area: 4,000 square feet.  
Total area: 8,000 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 10 feet.  
Group 26.

Building No. 17.  
Occupancy: Fuel hoppers for furnaces in building 15.  
Building type: Special industrial (S).  
Fire classification: N.  
Ground zero: 3,900 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Corrugated iron	0	100	Blast	
Trusses: Steel	10	0	do	
Columns: Steel	0	0	do	
Second floor: Steel	0	20	Debris	
First floor: Earth	0	10	do	
Foundation: Reinforced concrete	0	0	do	
Exterior walls: Corrugated iron	0	100	Blast	
Windows: None	0	100	do	
Contents: Hoppers	0	10	do	

Remarks: Figures 18 and 19; Photo 123.

# DAMAGE ANALYSIS

Dimensions: 75 by 60 feet.  
Ground floor area: 4,500 square feet.  
Total area: 4,500 square feet.  
Number of floors: 1.  
Eave height: 48 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 18.  
Occupancy: Boilers.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Bent 1-2 feet to south. Photos 124 and 125.
Trusses: Steel	20	0	do	
Columns: Steel	50	0	do	
First floor: Reinforced concrete	0	10	Debris	
Basement: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated iron	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: Conveying equipment	0	10	Debris	
boilers and equipment.				

Remarks: Figure 20; Photos 124 and 125.

## DAMAGE ANALYSIS

Dimensions: 380 by 68 feet.  
Ground floor area: 31,000 square feet.  
Total area: 31,000 square feet.  
Number of floors: 1.  
Eave height: 87 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 19.  
Occupancy: Heavy Forgings.  
Building type: Steel frame (B1).  
Fire classification: N.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Photos 122 and 127. Photos 126, 128, and 130.
Trusses: Steel	0	0		
Columns: Steel	3	0	H. E. b o m b blast.	
First floor: Concrete	0	0		See photo 128. Photos 127 and 131.
Basement: Corrugated iron	0	100	Blast	
Windows: Steel sash	0	100	do	
Contents: 1 180-ton crane; 1 70-ton crane.	0	0		

Remarks: Heavy construction; minor damage only. Figures 18 and 19; Photos 122, 126, 127, 128, 130, and 131.

# DAMAGE ANALYSIS

Dimensions: 110 by 60 feet.  
Ground floor area: 4,500 square feet.  
Total area: 9,000 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 20.  
Occupancy: Office and laboratory.  
Building type: (E1) R/C.  
Fire classification: R.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete	0	0		
Columns: Reinforced concrete	0	0		
Second floor: Reinforced concrete	0	0		
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Interior walls: Wood lath and plaster	0	30	Blast	
Windows: Steel sash	0	100	do	

Remarks: Earthquake-resistant construction. Figure 20; Photo 129.

## DAMAGE ANALYSIS

Dimensions: 35 by 29 feet.  
Ground floor area: 1,000 square feet.  
Total area: 1,000 square feet.  
Number of floors: 1.  
Eave height: 24 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 21.  
Occupancy: Transformer and switch station.  
Building type: Concrete special (D).  
Fire classification: R.  
Ground zero: 4,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete	0	0		
Columns: Reinforced concrete	0	0		
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Interior walls: Reinforced concrete	0	0		
Windows: Steel sash	0	100	Blast	

Remarks: Building practically undamaged. Figure 20.

# DAMAGE ANALYSIS

Dimensions: 150 by 70 feet.  
Ground floor area: 10,500 square feet.  
Total area: 10,500 square feet.  
Number of floors: 1.  
Eave height: 47 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 22.  
Occupancy: Heat treatment plant.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 3,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Photo 132.
Trusses: Steel	5	0	do	
Columns: Steel	5	0	do	
First floor: Earth	0	0		
Foundation: Reinforced concrete	0	100	Blast	
Exterior walls: Corrugated iron	0	100	do	
Windows: Wood sash	5	0	Debris	
Contents: Furnace; overhead crane	5	0		

Remarks: Figures 18 and 19; Photo 132.

# DAMAGE ANALYSIS

Dimensions: 482 by 184 feet.  
Ground floor area: 88,800 square feet.  
Total area: 88,800 square feet.  
Number of floors: 1.  
Eave height: 47 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 23.  
Occupancy: Heavy machine shop, ship parts, and munitions.  
Building type: Steel frame (B1).  
Fire classification: N.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	North line main columns O.E. crane girders overturned; all trusses failed. Row (B) columns failed either by bending or breaking from foundations. Row (A) columns failed in bending. Photos 134, 135, 137, and 138.
Trusses: Steel	100	0	do	
Columns: Steel	40	0	do	
First floor: Earth				
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated iron	10	0	Blast	
Windows: Steel sash	0	100	do	
Contents: Transformer station	0	100	do	
	0	5	Weather	

Remarks: Figures 18 and 19; Photos 134, 135, 136, 137, and 138.

# DAMAGE ANALYSIS

Dimensions: 100 by 45 feet.  
Ground floor area: 4,500 square feet.  
Total area: 4,500 square feet.  
Number of floors: 1.  
Eave height: 22 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 24.  
Occupancy: Unknown.  
Building type: Concrete and steel frame (D).  
Fire classification: N.  
Ground zero: 4,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	80	Blast	East wall blown in; small part north wall blown in. Dislodged from rails, not seriously damaged.
Trusses: Steel	0	0		
Columns: Reinforced concrete	30	0	Blast	
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	30	0	Blast	
Windows: Steel sash	0	100	do	
Contents: Traveling crane	0	20	do	

Remarks: Figure 20.

# DAMAGE ANALYSIS

Dimensions: 400 by 45 feet.  
Ground floor area: 1,800 square feet.  
Total area: 1,800 square feet.  
Number of floors: 1.  
Eave height: 24 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 25A.  
Occupancy: Shop.  
Building types: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,300.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Canted south; some bent; crippled at north end. Photos 138 and 140. Upturned. End wall of reinforced concrete; sidewalls of reinforced concrete and corrugated iron.
Trusses: Steel	100	0	do	
Columns: Steel	80	0	do	
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	40	0	Blast	
Exterior walls: Reinforced concrete and corrugated iron	0	100	do	
Windows: Steel sash	0	100	do	
Contents: Traveling cranes	0	50	do	

Remarks: Figure 20; Photos 138 and 140.

# DAMAGE ANALYSIS

Dimensions: 33 by 33 feet.  
Ground floor area: 1,100 square feet.  
Total area: 1,100 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 25B.  
Occupancy: Auxiliary building to 25A (office).  
Building type: Steel frame; concrete panel wall.  
(D).  
Fire classification: N.  
Ground zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	
Trusses: Steel	100	0	do	
Columns: Steel	0	0		
First floor: Reinforced concrete	0	10	Debris	
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	0	10	Blast	
Windows: Steel sash	0	100	do	

# DAMAGE ANALYSIS

Dimensions: 620 by 80 feet.  
Ground floor area: 49,600 square feet.  
Total area: 99,700 square feet.  
Number of floors: 2.  
Eave height: 45 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 26.  
Occupancy: Machine shop; torpedo assembly.  
Building type: Multistory (E2).  
Fire classification: M; roof C, remainder N.  
Ground zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	100	Fire and blast	Photo 139.
Trusses: Steel	100	0	do	
Columns: Steel	90	0	do	
Second floor: Reinforced concrete on steel	100	0	do	
First floor: Reinforced concrete on ground	0	20	Debris	Derailed and down.
Foundation: Reinforced concrete	0	0		
Exterior walls: Corrugated iron	0	100	Fire and blast	
Windows: Steel sash	0	100	do	
Contents: Traveling cranes	0	50	Blast	

Remarks: Figure 21; Photos 139 and 141.

# DAMAGE ANALYSIS

Dimensions: 87 by 58 feet.  
Ground floor area: 5,050 square feet.  
Total area: 22,000 square feet.  
Number of floors: 5.  
Eave height: 61 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 27.  
Occupancy: Office and storage.  
Building type: Multistory, reinforced concrete, steel frame (E2).  
Fire classification: N.  
Ground zero: 4,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 4-inch reinforced concrete	100	0	Blast	Roof collapsed.
Trusses: Steel	100	0	do	
Columns: Steel	0	0		
Fifth floor: 5-inch reinforced concrete on steel	0	0		
Fourth floor: 5-inch reinforced concrete on steel	0	0		
Third floor: 5-inch reinforced concrete on steel	0	0		
Second floor: 5-inch reinforced concrete on steel	0	0		
First floor: Reinforced concrete on ground	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: 6-inch reinforced concrete	5		Blast	
Interior walls: Lath and plaster; reinforced concrete	0	40	do	
Windows: Steel sash	0	100	do	
Finish: Wood	0	60		

Remarks: Earthquake-resistant construction. Figure 22; Photos 142 and 143.

# DAMAGE ANALYSIS

Dimensions: 90 by 60 feet.  
Ground floor area: 5,400 square feet.  
Total area: 10,800 square feet.  
Number of floors: 2.  
Eave height: 31 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 28.  
Occupancy: Unknown.  
Building type: Multistory, reinforced concrete (E1).  
Fire classification: R.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete, 87 percent; corrugated iron, 13 percent.	0	13	Blast	
Trusses: Steel over 13 percent of building.	100	0	do	
Columns: 18- by 18-inch reinforced concrete.	0	0		
Second floor: 6-inch reinforced concrete.	0	0		
First floor: Reinforced concrete	0	0		
Exterior walls: 6½-inch reinforced concrete.	0	0		
Interior walls: Reinforced concrete	0	0		
Windows: Wood sash	0	100	Blast	

Remarks: Building in good condition; earthquake-resistant construction. Figure 23; Photos 146 and 147.

# DAMAGE ANALYSIS

Dimensions: 575 by 119 feet.  
Ground floor area: 68,500 square feet.  
Total area: 68,500 square feet.  
Number of floors: 1.  
Eave height: 28 feet 6 inches.  
Mean elevation: 10 feet.  
Group 26.

Building No. 29.  
Occupancy: Machine shop.  
Building type: Warehouse, reinforced concrete (B2).  
Fire classification: R.  
Ground zero: 4,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced-concrete arch	50	0	Blast	Arch collapsed down. Photo 148.
Columns: Reinforced concrete	40	0	do	
First floor: Reinforced concrete	10	0	do	Uprooting of columns and wall footings. Photo 145, 152, and 153.
Foundation: Reinforced concrete	15	0	do	
Exterior walls: Reinforced concrete	30	0	do	
Windows: Wood sash	0	100	do	
Contents: 3 traveling cranes	0	0		

Remarks: Figures 23, 24; Photos 144, 145, 148, 149, 151, 152, and 153.

# DAMAGE ANALYSIS

Dimensions: 500 by 50 feet.  
Ground floor area: 25,000 square feet.  
Total area: 25,000 square feet.  
Number of floors: 1.  
Eave height: 23 feet.  
Mean elevation: 10 feet.  
Group 26.

Building No. 30.  
Occupancy: Machine shop.  
Building type: Reinforced-concrete warehouse (B2).  
Fire classification: R.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 4-inch, reinforced-concrete arch slab on reinforced-concrete ribs.	100	0	Blast	Arch collapsed down. Photo 150.
Columns: Reinforced concrete	30	0	do	
First floor: Reinforced concrete	0	50	Debris	
Foundation: Reinforced concrete	0	0		
Exterior walls: 6-inch reinforced concrete.	30	0	Blast	
Windows: Wood sash		100	do	
Contents: Traveling cranes	100	0	do	

Remark: Figure 23; Photo 150.

# DAMAGE ANALYSIS

Dimensions: 460 by 50 feet.  
Ground floor area: 23,000 square feet.  
Total area: 23,000 square feet.  
Number of floors: 1.  
Eave height: 31 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 31.  
Occupancy: Machine shop.  
Building type: Warehouse (B2); reinforced concrete.  
Fire classification: R.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 6-inch, reinforced-concrete arch slab on 12- by 18-inch reinforced-arch ribs.	100	0	Blast	Collapsed. Photos 154, 155.
Columns: 12- by 30-inch reinforced concrete.	90	0	do	Photo 155.
First floor: Reinforced concrete	0	0	do	
Foundation: Reinforced concrete	50	0	Blast	
Exterior walls: 10- by 6-inch reinforced concrete.	95	0	do	Photo 156.
Windows: Wood sash	0	100	do	
Contents: Traveling crane	20	0	do	
Machine tools	100	0	do	

Remarks: Figure 23; Photos 154 through 158, inclusive.

## DAMAGE ANALYSIS

Dimensions: 55 by 35 feet.  
Ground floor area: 1,900 square feet.  
Total area: 1,900 square feet.  
Number of floors: 1.  
Eave height: 23 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 32.  
Occupancy: Boiler house.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	100	Blast	Photo 159.
Trusses: Steel	85	0	do	
Columns: Steel	60	0	do	
First floor: Reinforced concrete on earth.	0	5	Debris	
Foundation: Reinforced concrete	0	0		
Exterior walls: Steel-frame, 6-inch, concrete panels, very light.	60	0	Blast	North and south walls bowed southward by blast. East and west walls gone. Photo 159.
Windows: Steel sash	0	100	do	
Contents: Boilers and accessories	0	10	Blast and debris	

Remarks: Figure 23; Photo 159.

# DAMAGE ANALYSIS

Dimensions: 38 by 36 feet.  
Ground floor area: 1,400 square feet.  
Total area: 1,400 square feet.  
Number of floors: 2.  
Eave height: 25 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 33.  
Occupancy: Transformer and switch room.  
Building type: Steel and concrete frame; wall-bearing (D).  
Fire classification: C.  
Ground zero: 4,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron and wood	0	90	Blast	Photo 160.
Trusses: Steel	100	0	do	
Columns: 18- by 23-inch reinforced concrete.				
Mezzanine floor: Steel	0	40	Shock	Jolted down but not damaged.
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	25	0	Blast	Photo 160.
Exterior walls: 9-inch reinforced concrete.				
Windows: Steel sash	0	100	do	
Contents: Transformers, switches and crane.	0	0		

Remarks: Figure 23; Photo 160.

# DAMAGE ANALYSIS

Dimensions: Building 34-95 by 85 feet over all;  
building 35-50 by 30 feet.  
Ground floor area: 6,400 square feet.  
Total area: 10,000 square feet.  
Number of floors: 2.  
Eave height: 26 feet.  
Mean elevation: 10 feet.

Group 26.  
Building Nos. 34 and 35.  
Occupancy: Offices.  
Building type: Office multistory (D) reinforced concrete.  
Fire classification: R.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Reinforced concrete.....	0	5	Blast.....	North and south parapet walls down.
Columns: Reinforced concrete.....	0	0	.....	
Second floor: Reinforced concrete.....	0	0	.....	
First floor: Reinforced concrete.....	0	0	.....	
Basement: Open space under floor unfinished.....	0	0	.....	
Foundation: Reinforced concrete.....	0	0	.....	
Exterior walls: Reinforced concrete.....	0	60	Blast.....	
Interior walls: Wood frame, plastered.....	0	100	do.....	
Windows: Steel sash.....	0	30	do.....	
Finish: Wood and plaster.....	0	30	do.....	

Remarks: Buildings in good condition. Figure 21; Photo 161.

# DAMAGE ANALYSIS

Dimensions: Unknown.  
Ground floor area: Unknown.  
Total area: Unknown.  
Number of floors: Unknown.  
Eave height: Unknown.  
Mean elevation: 10 feet.

Group 26.  
Building Nos. 36 to 40, 42 to 46.  
Occupancy: Unknown.  
Building type: Wooden.  
Fire classification: C.  
Ground zero: 3,800 feet.

These buildings completely destroyed by blast and fire. Photos 162 and 163.

# DAMAGE ANALYSIS

Dimensions: 396 by 198 feet.  
Ground floor area: 78,408 square feet.  
Total area: 78,408 square feet.  
Number of floors: 1.  
Eave height: 41 feet.  
Mean elevation: 10 feet.

Group 26.  
Building No. 41.  
Occupancy: Brick kilns, woodwork shop.  
Building type: Heavy steel frame (A2-3).  
Fire classification: N.  
Ground zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated iron.....	0	100	Blast.....	
Trusses: Steel.....	0	0	.....	
Columns: Steel.....	0	0	.....	
First floor: Concrete on earth.....	0	0	.....	
Foundation: Reinforced concrete piers.....	0	0	.....	
Exterior walls: Corrugated iron.....	0	100	Blast.....	
Windows: Steel sash.....	0	100	do.....	
Contents: Transformer station and switchboard.....	0	0	.....	
.....	0	0	.....	
.....	0	0	.....	

Remarks: Figure 22; Photos 164 and 165.

## 10. Mitsubishi Steel and Arms Casting Plant—Group 31

a. This group of buildings was situated on the western side of the Urakami River at a distance of approximately 4,500 feet south of GZ. It consisted of 15 buildings and a coal storage yard, covering a total plan area of approximately 97,000 square feet. The greater portion of the building

area was occupied by the 6 steel-frame buildings which constituted approximately 83 percent of the total plan area. Buildings 8, 9, and 11 contained overhead traveling cranes. The one reinforced-concrete building (Building 10) contained transformers and switch gear, and was partly roofed with a wooden truss. The building areas and types were as follows:

Building classification—Group 31

Building No.	Area		Type	Fire class	Construction		
	Plan (square feet)	Total (square feet)			Steel frame	Reinforced concrete	Wood
1	11,130	11,130	A2.3	N	X		
2	369	369	D	C			X
3	943	943	D	C			X
4	1,596	1,596	D	C			X
5	725	725	S	N	X		
6	368	368	D	N	X		
7	12,312	12,312	B2	N	X		
8	14,075	14,075	B2	N	X		
9	1,134	1,700	E2	C&R		X	
10	41,600	41,600	B2	N	X		
11							X
12							X
13							X
14							X
15							X
16							X
Total	95,322	95,889			6	1	

1. Coal-storage yard.

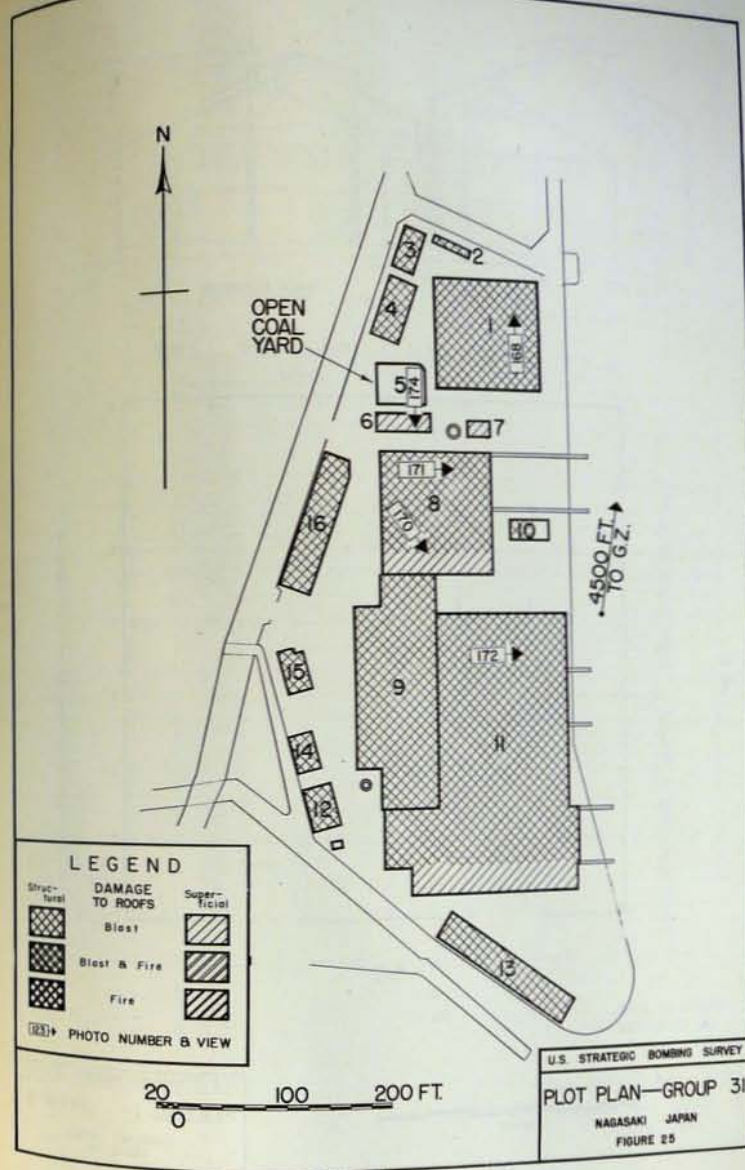
b. Of the steel-frame buildings, only two (Buildings 6 and 7) escaped structural damage, but the roofing and siding were stripped from these structures. The other steel-frame buildings (Nos. 1, 8, 9, and 11) sustained structural damage to varying degrees in addition to having nearly all of the siding and roofing removed by blast. In many cases the force of the blast caused the corrugated iron which remained to take the shape of the steel frame members supporting it (Photo 174).

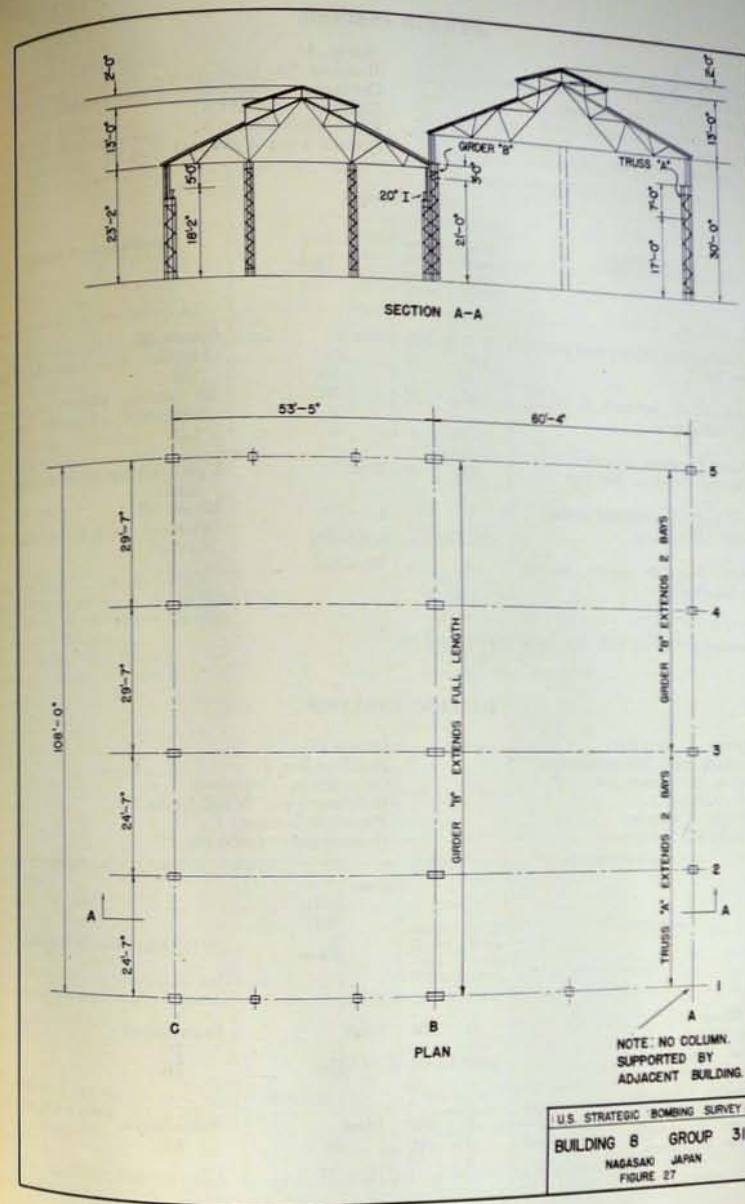
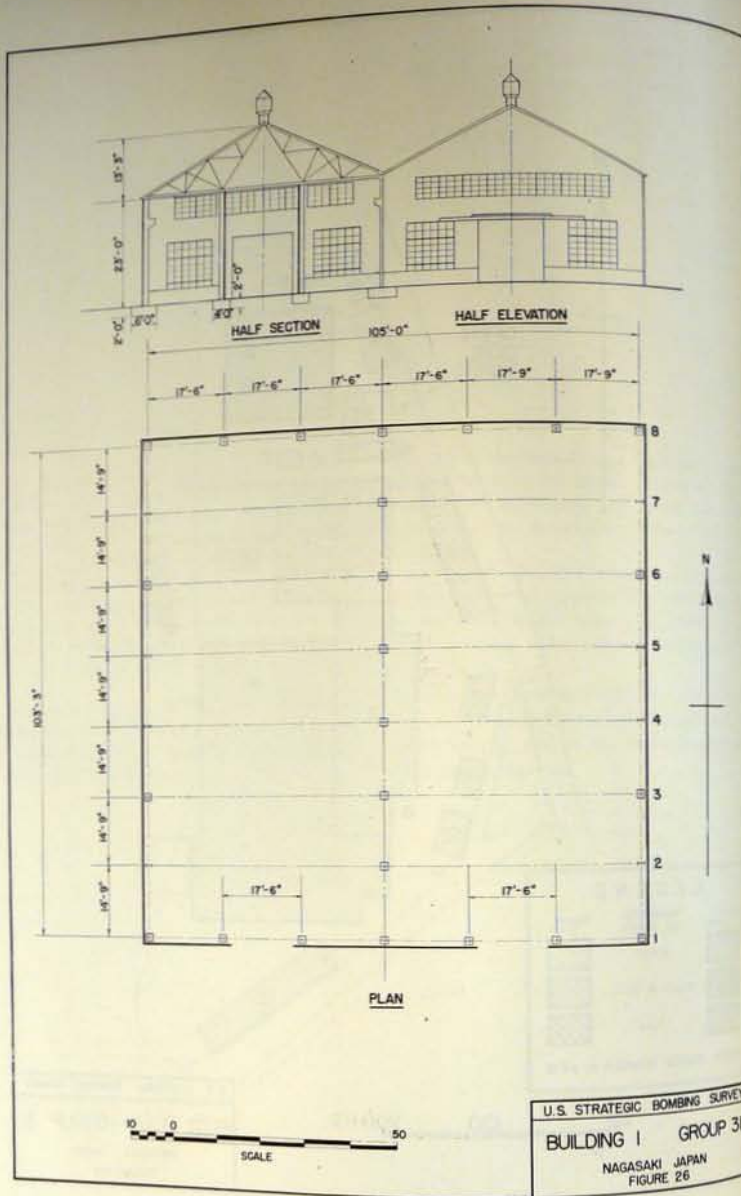
c. The only damage to the one reinforced-concrete building (Building 10) consisted of structural damage to the wooden trusses covering the west half of the building.

d. All of the wood-frame buildings were structurally damaged by blast. Much of the debris from these structures had been cleared away, leaving only the foundation walls to indicate their location.

e. The only evidence of fire was a burned wooden fence at the west property line and some charred timber which might have been formerly a shed-type structure. The fire was slight and of unknown origin.

f. Further information about buildings in this group is shown in Photos 166 through 174, Figures 25, 26, and 27, and on the damage analysis sheet following the figures.





# DAMAGE ANALYSIS

Dimensions: 105 by 106 feet.  
Ground floor area: 11,130 square feet.  
Total area: 11,130 square feet.  
Number of floors: 1.  
Eave height: 21 feet.  
Mean elevation: 10 feet.

Group 31.  
Building No. 1.  
Occupancy: Smith shop (Steel frame).  
Building type: (A2.3).  
Fire classification: N.  
Ground zero: 4,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal; steel purlins.	0	100	Blast	Blown off.
Trusses: Steel	100	0	do	Crippled and canted. Photos 168.
Columns: Steel, latticed 18 by 18 inches maximum.	100	0	do	All canted, about 10 percent distorted. Photos 169 and 173.
First floor: Concrete on earth.	0	0		
Foundation: Concrete footings.	10	0	Blast	Uprooted by overturning columns.
Exterior walls: Corrugated metal.	0	100	do	Blown off.
Windows: Metal sash.	0	100	do	Glass out, sash and frames distorted.
Contents: Portable hoists, ovens, shop benches, etc.	0	5	Weather	

Remarks: Photos 168, 169, and 173; Figure 26.

# DAMAGE ANALYSIS

Dimensions: 41 by 9 feet.  
Ground floor area: 369 square feet.  
Total area: 369 square feet.  
Number of floors: 1.  
Eave height: Unknown.  
Mean elevation: 10 feet.

Group 31.  
Building No. 2.  
Occupancy: Unknown.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	100	Blast	Demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood	100	0	do	Do.
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Wood	0	0		
Windows: Wood sash	0	100	Blast	Demolished.
Contents: Unknown	0	100	do	Do.

# DAMAGE ANALYSIS

Dimensions: 41 by 23 feet.  
Ground floor area: 943 square feet.  
Total area: 943 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 31.  
Building No. 3.  
Occupancy: Parts storage.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos; wood purlins.	0	100	Blast	Demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood	100	0	do	Do.
First floor: Concrete on earth.	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated asbestos.	0	100	Blast	Demolished.
Windows: Wood sash	0	100	do	Do.

# DAMAGE ANALYSIS

Dimensions: 57 by 28 feet.  
Ground floor area: 1,596 square feet.  
Total area: 1,596 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 31.  
Building No. 4.  
Occupancy: Storage.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos; wood purlins.	0	100	Blast	Demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood	100	0	do	Do.
First floor: Concrete on earth.	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated asbestos.	0	100	Blast	Demolished.
Windows: Wood sash	0	100	do	Do.

# DAMAGE ANALYSIS

Dimensions: 40 by 50 feet, approximately.  
Ground floor area: 2,000 square feet.  
Mean elevation: 10 feet.  
Group 31.

Building No. 5.  
Occupancy: Open coal storage.  
Ground zero: 4,300 feet.

No building; concrete slab on earth, surrounded by reinforced concrete wall of maximum height 7 feet. No damage.

# DAMAGE ANALYSIS

Dimensions: 42 by 18 feet over all.  
Ground floor area: 726 square feet.  
Total area: 726 square feet.  
Number of floors: 1.  
Eave height: 33 feet maximum.  
Mean elevation: 10 feet.

Group 31.  
Building No. 6.  
Occupancy: Coal pulverizing unit.  
Building type: Steel frame (S).  
Fire classification: N.  
Ground zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal; steel purlins.	0	100	Blast	Stripped.
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Earth	0	0		
Foundation: Concrete footings.	0	100	Blast	Mostly stripped; remainder pressed out of shape against framing. Photo 174.
Exterior walls: Corrugated metal.	0	100		
Contents: Hoppers, mixer or pulverizer, filters, etc.	0	0		

Remarks: Photo 174.

# DAMAGE ANALYSIS

Dimensions: 23 by 16 feet.  
Ground floor area: 368 square feet.  
Total area: 368 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 10 feet.

Group 31.  
Building No. 7.  
Occupancy: Furnace.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 4,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal; steel purlins.	0	100	Blast	Stripped.
Trusses: Steel	0	0		
Columns: Steel	0	100	Blast	Canted 3 inches but not deformed as units.
First floor: Earth	0	0		
Foundation: Concrete and brick	0	0		Stripped.
Exterior walls: Corrugated metal	0	100	Blast	
Contents: Furnace of some kind	0	0		

# DAMAGE ANALYSIS

Dimensions: 108 by 114 feet.  
Ground floor area: 12,312 square feet.  
Total area: 12,312 square feet.  
Number of floors: 1.  
Eave height: 30 feet maximum.  
Mean elevation: 10 feet.

Group 31.  
Building No. 8.  
Occupancy: Heating and rolling mill.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal; steel purlins.	0	100	Blast	Stripped. Top chords bent. Bent.
Trusses: Steel	80	0	do	
Columns: Steel	5	0	do	
First floor: Concrete and earth	0	0		
Foundation: Concrete	0	0		Stripped. All glass out; 20 percent of sash deformed.
Exterior walls: Corrugated metal	0	100	Blast	
Windows: Metal sash	0	100	do	
Contents: Heating and rolling equipment; 2 traveling cranes.	0	5	Weather	

Remarks: Photos 170 and 171.

# DAMAGE ANALYSIS

Dimensions: 77 by 204 feet over all.  
Ground floor area: 14,075 square feet.  
Total area: 14,075 square feet.  
Number of floors: 1.  
Eave height: 28 feet.  
Mean elevation: 10 feet.

Group 31.  
Building No. 9.  
Occupancy: Rolling mill.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal; steel purlins.	0	100	Blast	Stripped. Crippled and canted.
Trusses: Steel	100	0	do	
Columns: Steel	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete	0	0		Stripped. Glass out.
Exterior walls: Corrugated metal	0	100	Blast	
Windows: Metal sash	0	100	do	
Contents: Rolling mill; ovens; 2 cranes.	0	0		

# DAMAGE ANALYSIS

Dimensions: 54 by 21 feet.  
Ground floor area: 1,134 square feet.  
Total area: 1,700 square feet.  
Number of floors: 1 and 2.  
Eave height: 24 feet.  
Mean elevation: 10 feet.

Group 31.  
Building No. 10.  
Occupancy: Substation.  
Building type: Reinforced concrete frame (E2).  
Fire classification: Part of roof C; remainder R.  
Ground zero: 4,400 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: West half: corrugated asbestos, wood purlins. Remainder: reinforced concrete slab.	0	50	Blast	Roof blown off west half.
Trusses: West half only: wood. Remainder: none.	100	0	do	Collapsed.
Columns: Reinforced concrete	0	0		
Second floor: Reinforced concrete (in east half only).	0	0		
First floor: Reinforced concrete on earth.	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Interior walls: Reinforced concrete	0	0		
Windows: Metal sash	0	100		Glass out; sash deformed.
Contents: Electrical equipment	0	0		

# DAMAGE ANALYSIS

Dimensions: 203 by 269 feet over all.  
Ground floor area: 41,600 square feet.  
Total area: 41,600 square feet.  
Number of floors: 1.  
Eave height: 23 feet.  
Mean elevation: 10 feet.

Group 31.  
Building No. 11.  
Occupancy: Steel mill.  
Building type: Steel frame (B2).  
Fire classification: N.  
Ground zero: 4,600 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated metal; steel purlins.	0	100	Blast	Stripped.
Trusses: Steel	80	0	do	Slight deformations.
Columns: Steel	2	0	do	1 intermediate column failed (bent).
Basement: Concrete and earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	100	Blast	Stripped.
Windows: Metal sash	0	100	do	Glass out; 40 percent of sash deformed.
Contents: Overhead cranes	0	0		

Remarks: Photo 172.

## DAMAGE ANALYSIS

Dimensions: Average 27 by 82 feet.  
Ground floor area: 11,070 square feet total.  
Total area: 11,070 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Miscellaneous small and unimportant structures, 100 percent structurally damaged (blast).

### 11. Zenza Substation—Group 33

a. This group situated between two hills, to the east and west, was composed of two buildings for the housing of switching equipment and a synchronous condenser. It was located approximately 5,400 feet southeast of GZ, and covered a total plan area of approximately 5,600 square feet.

b. Building 1 was constructed of brick, concrete, and steel. Photo 177 shows the type of construction. The switching equipment and the synchronous condenser were housed in this building which sustained considerable structural damage although it was partially protected by clay-filled blast walls. The blast forced the roof down and the north and east walls inward (Photos 176 to 179).

c. Building 2, constructed of brick walls and wood roof, was used as a warehouse. It was practically demolished by the blast. Part of the south and east walls remained standing although seriously cracked (Photo 180).

d. Damage to these buildings is shown on Photos 175 to 180, on Figure 28, and on the damage analysis sheets which follow.

### 12. Mitsubishi Woodworking Plant—Group 35

a. This group of buildings was used for the manufacture and storage of lumber. The plant was situated on the western bank of the Urakami River at a distance of approximately 5,700 feet south of GZ. There were approximately 14 buildings in the group, including 2 steel-frame structures (Buildings 1 and 2), one reinforced-concrete structure (Building 3), and approximately 11 wood-frame buildings and sheds. The wood-frame buildings were used for storage of lumber, and for offices, canteens, and the like. As these wooden buildings were completely destroyed by blast and the debris removed, the exact number could not be determined.

b. The principal building (No. 1) covered a plan area of 28,224 square feet and was used to

Group 31.  
Building Nos. 12, 13, 14, 15, 16.  
Occupancy: Miscellaneous.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 4,600 feet average.

house machinery for manufacturing sized lumber from logs. The other steel-frame building (No. 2) covered a plan area of 950 square feet and housed transformers and switch gear. The reinforced-concrete building (No. 3) occupied a plan area of 2,500 square feet and was used for a dry kiln.

c. Fire was the principal cause of the damage in Building 1. In addition to the lumber stored in this building the floors were of heavy plank on timber girders, and all the wood was consumed by fire. The intense heat caused the steel columns to soften and collapse as shown in Figure 30 and Photos 181, 182, and 183. It was impossible to separate the extent of damage caused by blast and by fire, although it was estimated that 90 percent of the structural damage could be attributed to fire.

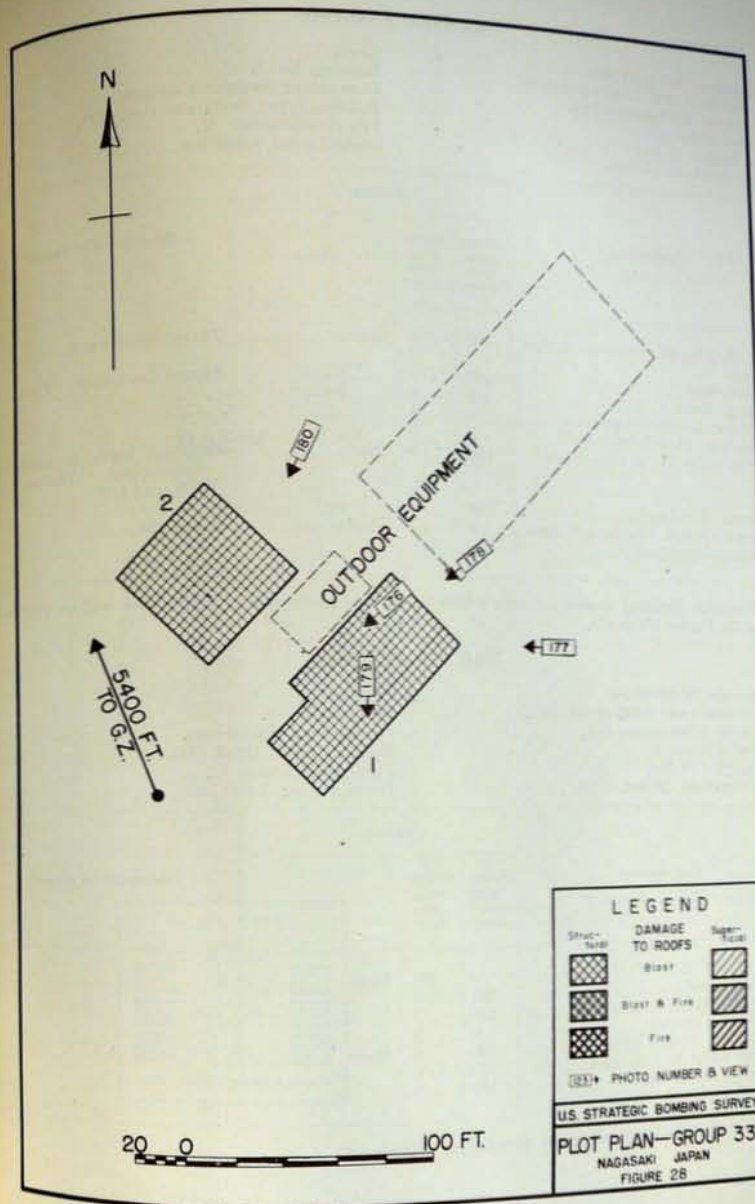
d. Only superficial damage was sustained by Building 2, the other steel-frame building in the group. There was no combustible material and no fire in this building.

e. The reinforced-concrete structure (No. 3) was constructed with heavy beam and roof slabs and sustained no damage.

f. The cause of fire at this plant could not be definitely determined. There was no evidence of electrical fire. Dwellings across the road to the west were damaged by blast only. Flash burns were found on logs floating in the log basin immediately to the north.

g. Fire protection at the plant consisted of public water supply and hydrants, static water tanks and small hand pumps and fire extinguishers. Water from the river and the log basin was available.

h. Further information regarding the construction and damage in this group may be found in Photos 181 through 186, on Figures 29 and 30, and on the damage analysis sheets immediately following the figures.



# DAMAGE ANALYSIS

Dimensions: 83 by 40 feet.  
Ground floor area: 3,100 square feet.  
Total area: 3,100 square feet.  
Number of floors: 1.  
Eave height: 32 feet.  
Mean elevation: 15 feet.

Group 33.  
Building No. 1.  
Occupancy: Switching station.  
Building type: Brick and steel (D).  
Fire classification: N.  
Ground zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete arched panels	100	0	Blast	Thrust downward.
Trusses: Steel	100	0	do.	Thrust downward. Photo 176.
Columns: Brick	100	0	do.	
First floor: Reinforced concrete	0	0		
Foundation: 24-inch brick walls	0	0		
Exterior walls: 12- to 18-inch brick	100	0	Blast	East wall blown in; north wall demolished. Photos 178, and 179.
Windows: Wood sash	100	0	do.	
Contents: Switch boards and synchronous condenser.	0	10	Debris	Photo 176.

Remarks: Building located between 2 hills, north and south sides. Clay blast wall on east face. Figure 28; Photos 175 to 179.

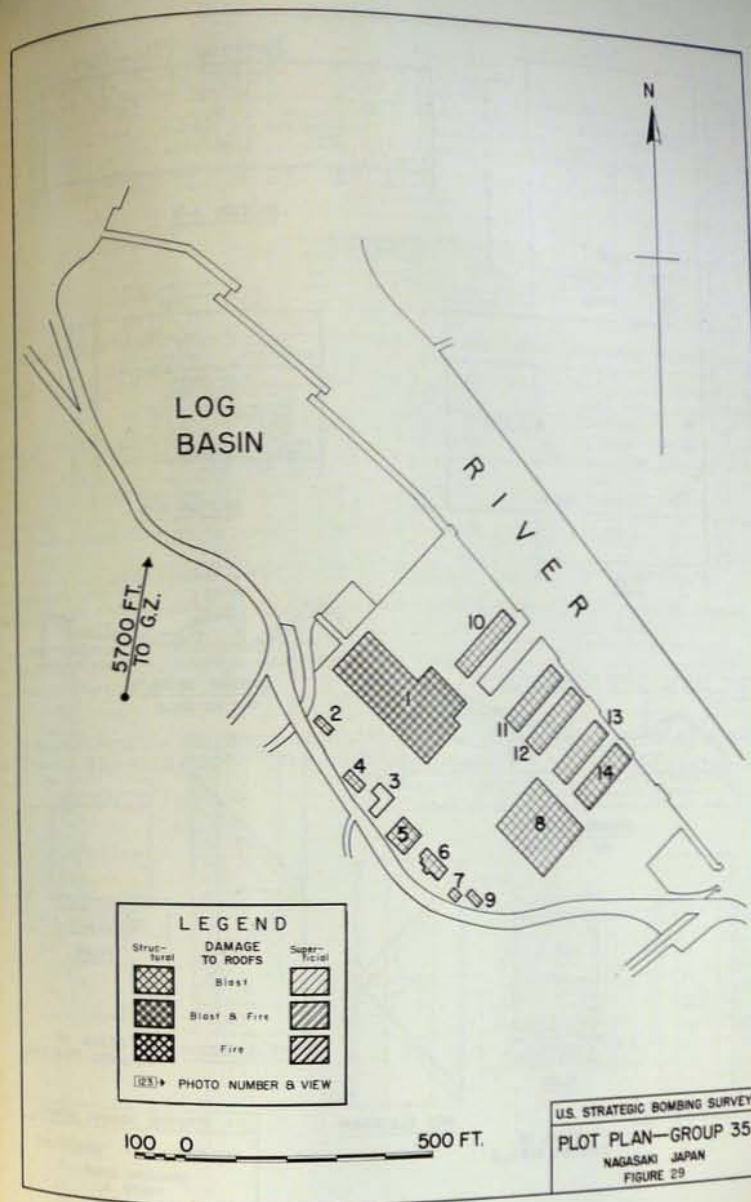
## DAMAGE ANALYSIS

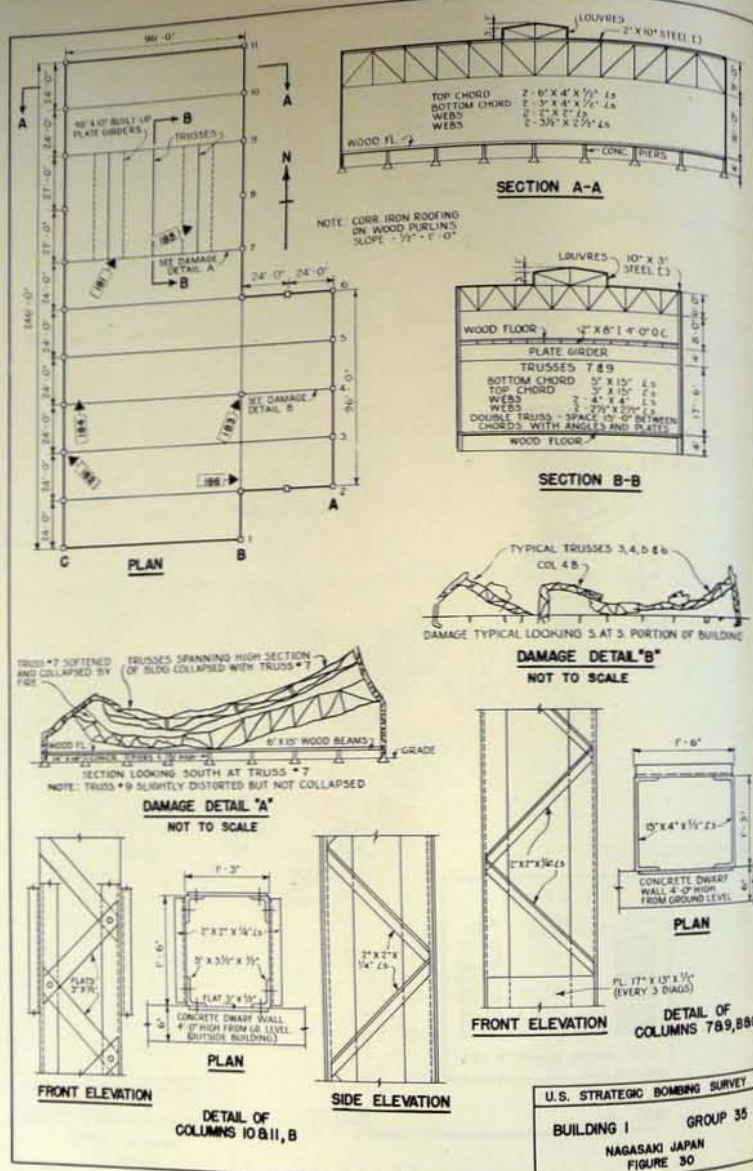
Dimensions: 50 by 50 feet.  
Ground floor area: 2,500 square feet.  
Total area: 2,500 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 15 feet.

Group 33.  
Building No. 2.  
Occupancy: Warehouse.  
Building type: Brick (D).  
Fire classification: C.  
Ground zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	100	Blast	
Trusses: Wood	100	0	do.	
Columns: Brick	100	0	do.	
First floor: Concrete	0	0		
Foundation: 12-inch brick	100	0	Blast	
Exterior walls: 12-inch brick	100	0	do.	
Windows: Wood sash	100	0	do.	

Remarks: Building completely demolished. Photo 180.





## DAMAGE ANALYSIS

Dimensions: 120 by 246 feet over all.  
 Ground floor area: 28,224 square feet.  
 Total area: 33,408 square feet.  
 Number of floors: 2.  
 Eave height: 39 feet 6 inches.  
 Mean elevation: 6 feet.

Group 35.  
 Building No. 1.  
 Occupancy: Lumber mill.  
 Building type: Steel frame.  
 Fire classification: C.  
 Ground zero: 5,600 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Corrugated iron on steel purlins.	0	100	Fire and blast	All roofing blasted from steel frame.
Trusses: Heavy steel	100	0	do	Steel trusses distorted by intense heat. Photos 181, 183, and 185.
Columns: Heavy steel	100	0	do	Columns distorted by blast and fire. Photos 182, 184, and 186.
Second floor: Wood flooring on wood timbers.	100	0	Fire	Completely burned.
First floor: Wood flooring on wood timbers.	0	0	do	Do.
Foundation: 14- by 14-inch piers, reinforced concrete.	0	0		No damage found.
Exterior walls: Corrugated iron	0	100	Blast and fire	Wall covering blasted from steel frame.
Windows: Glass set in steel frame	0	100		Completely destroyed.
Contents: Woodworking machinery; stocks of wood.	100	0	Fire	All contents destroyed by fire.

Remarks: Structure completely collapsed by blast and fire. Fire caused 90 percent of damage to steel frame. Figures 29 and 30; Photos 181 through 186, inclusive.

# DAMAGE ANALYSIS

Dimensions: 10 by 50 feet.  
Ground floor area: 950 square feet.  
Total area: 950 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 6 feet.

Group 35.  
Building No. 2.  
Occupancy: Transformer house.  
Building type: Steel frame.  
Fire classification: N.  
Ground zero: 5,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Asbestos roofing on wood purlins.	0	100	Blast	Roofing blasted from frame.
Trusses: Light steel.	0	0		Undamaged.
Columns: Built-up lattice I-beam shape—12 inches deep.	0	10	Blast	Slight distortion of 2 columns at north end of building.
First floor: Concrete on earth.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	100	Blast	Siding blasted from steel frame.
Windows: Clear glass in steel frame.	0	100	do.	All glass broken.
Contents: Transformers and switch gear.	0	0		No damage.

Remarks: Figure 29.

# DAMAGE ANALYSIS

Dimensions: 50 by 50 feet over all.  
Ground floor area: 2,500 square feet.  
Total area: 2,500 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 6 feet.

Group 35.  
Building No. 3.  
Occupancy: Dry kiln.  
Building type: Reinforced concrete.  
Fire classification: R.  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced-concrete slab.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Reinforced concrete.	0	0		
Exterior walls: 8-inch reinforced concrete.	0	0		
Interior walls: 8-inch reinforced concrete.	0	0		

Remarks: No damage to this structure. Figure 29.

# 13. Mitsubishi Turbine Component Works No. 1—Group 36

a. This group of 22 buildings and a smoke stack, located 5,400 feet south of GZ, housed a plant for the manufacture of complete steam turbines. The buildings covered a total plan area of approximately 318,000 square feet and a total floor area of approximately 340,000 square feet. Several building types and all fire classifications were represented in the group, as listed below.

b. Damage to the group was due to both blast and fire, and ranged from minor damage to complete collapse.

c. The two steel-frame buildings (Nos. 8 and 16) constituted 60 percent of the total plan area. They were one-story mill-type structures with traveling cranes in all bays, and with triangular roof trusses with one upper chord continued beyond the ridge to form an asymmetrical vertical roof light on the north side. The lower part of these lights had glazing in wood frames, while the upper part consisted of wood ventilating louvers which were sheathed in wood, presumably for black-out purposes. Building 8 was a heavy machine shop; building 16 a heat treatment shop; and contents of both were of very low combustibility.

(1) Building 8 was stripped of roofing and wall covering by blast, and a fire occurred in the roof of the third bay from the south end of the building. Here the wood part of the roof light was burned, and the steel part was affected by fire in which longitudinal and cross bracing members were buckled. The lower part of the trusses was not affected, although the wood purlins were burned out in a number of places. It was concluded that this was an instance of primary fire caused by direct heat radiation on the wood sheathing in front of the louvers. Corresponding sheathing in other bays was charred black. The bay damaged by fire was several feet higher than those in front of it and so received the full effect of the bomb, whereas the other bays screened one another.

(2) Building 16 was damaged by blast only. The bay nearest GZ was structurally damaged, but the rest of the building suffered only superficial damage; i. e., stripping of roof and walls.

d. Only one very small building (No. 10), covering less than one-half of 1 percent of total plan area of the group, was of reinforced-concrete construction. Its only damage was minor metal fire shutters over window openings were bowed in by blast.

e. Of the 7 buildings of load-bearing-wall con-

## Building classification—Group 36

Building No.	Area		Type	Fire class	Construction			
	Plan (square feet)	Total (square feet)			Steel frame	Reinforced concrete	Load-bearing wall	Wood
1	54,700	54,700	B2	C				X
2	660	660	D	C				X
3	384	384	D	C				X
4	50	50	S	N	X			X
5	440	440	D	C				X
6	3,200	3,200	D	C				X
7	1,120	1,120	D	C				X
8	132,300	132,300	B1	N	X			
9	10,800	10,800	A2.3	C		X	X	
10	1,530	1,530	D	R				
11								
12								
13	12,400	12,400	D	C			(4) X	
14								X
15	2,400	2,400	D	C				X
16	58,000	58,000	B1	N	X			X
17	5,400	5,400	D	C			X	X
18	3,500	3,500	D	N				(2) X
19	6,700	6,700	D	C				
20	14,700	29,400	E2	C			X	X
21	1,500	1,500	D	N				
22	7,900	15,800	E2	C				
Total	317,684	340,284			(7)	1	7	12

1 Smokestack.  
2 and smokestack.

struction (Nos. 9, 11, 12, 13, 14, 18, and 22), constituting 9 percent of total plan area, building 18, with steel roof trusses on brick walls, was superficially damaged, while building 22, of similar construction but slightly lighter walls, suffered structural damage. The others had timber trusses on brick walls and were practically 100 percent structurally damaged. All damage to these seven buildings was solely from blast.

f. The remaining 12 buildings of the group (Nos. 1, 2, 3, 5, 6, 7, 15, 17, 19, 20, 21, and 23), constituting 31 percent of total plan area, were classified as wooden buildings. In two of these (17 and 19), however, the outer ends of the timber roof trusses were carried on brick walls, with timber columns in the interior. All suffered 100 percent structural damage, attributable to blast and fire in Buildings 1, 6, 7, 19, and 23, and to blast alone in the others.

Buildings 1, 6, 7, and 19 warrant special mention.

(1) Building 1 was a large one-story structure with tile-covered roof and concrete floor. A traveling crane occupied half of the building. A combination of fire and blast damage destroyed the entire structure and its contents. The fire was probably of secondary origin; there were numerous furnaces and braziers from which the fire could have started.

(2) Building 6, housing the steam power plant, was a high one-story, timber-frame structure with corrugated-metal roofing, wood walls, and concrete floor. It was structurally damaged by blast, and fire consumed most of the timber framing. The fire probably started from the boiler. The build-

ing was shielded from radiant heat by Building 6 and fire spread from Building 1 or 7 seemed improbable.

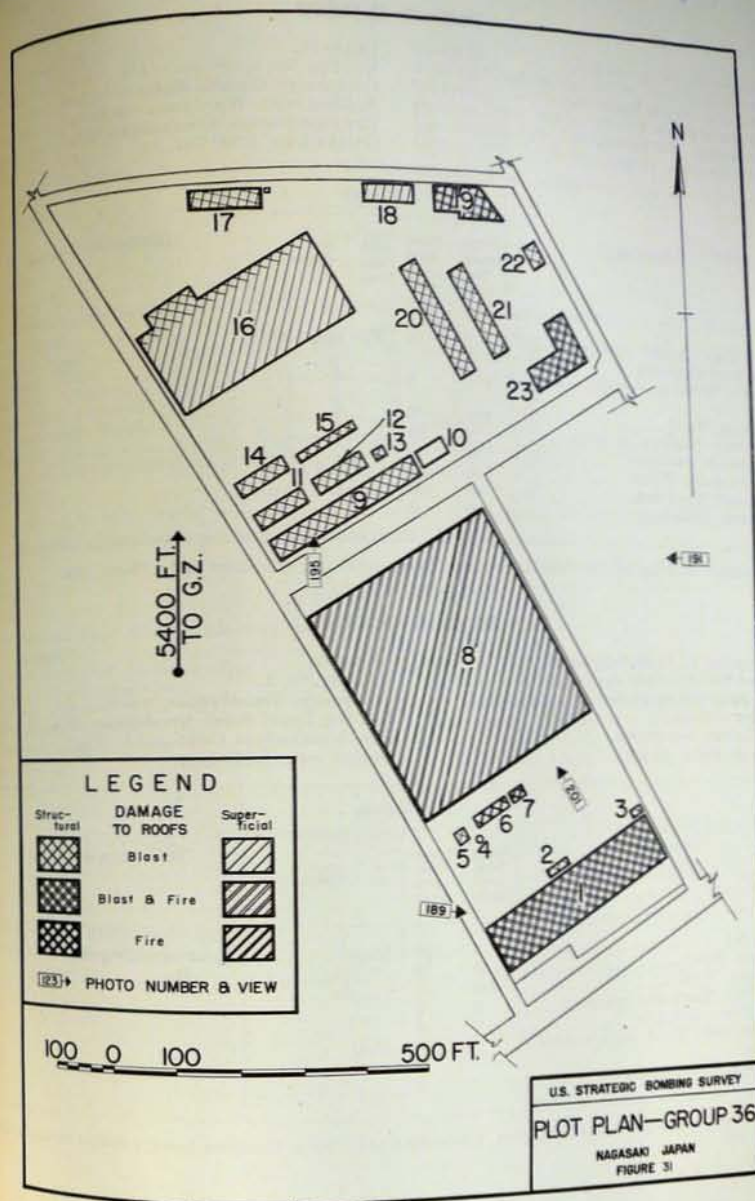
(3) Unusual construction which accounted for the peculiar nature of the damage was found in Building 7. This small timber structure contained a heavily built, reinforced-concrete room which housed the compressors. The wood structure was completely destroyed by blast and fire which also seriously damaged the switch gear for the compressors. The compressors themselves and their protecting enclosure escaped serious damage, although heat caused some slight spalling of the concrete surface. The fire was caused by flagration from Building 1.

(4) Building 19 was a one-story structure with tile-covered roof and concrete floor, which housed a fire truck, small hand wagons, cafeteria, and kitchen. The west (garage) part of the building was separated from the remainder by a brick division wall with a large doorway. The building collapsed as a result of blast after which fire consumed the timbers and all inflammable contents. The fire was probably of secondary origin since a brazier noted among the debris or the cooking stoves could have been the source. The possibility of the building's having been ignited by fire spread was slight.

g. Following is a summary of fire damage to buildings and contents:

h. Further information regarding the construction of the buildings in this group and the damage sustained by them will be found in Photos 187 through 202, in Figure 31, and on the damage analysis sheets immediately following the figures.

Building No.	Occupancy	Fire class	Estimated damage			
			Blast and fire, buildings		Fire, contents	
			Superficial	Structural		
1.	Machine shop.	C	Total	Total	Total	Total
6.	Steam plant.	C	do.	do.	Do.	Do.
7.	Compressor house.	C	Serious	Serious	Slight	Slight
8.	Heavy machine shop.	N	Total	Total	Total	Total
19.	Garage, kitchen, cafeteria.	C	do.	do.	do.	do.



# DAMAGE ANALYSIS

Dimensions: 360 by 152 feet.  
Ground floor area: 54,700 square feet.  
Total area: 54,700 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 36.  
Building No. 1.  
Occupancy: Machine shop.  
Building type: Wood frame (B2).  
Fire classification: Combustible (C).  
Ground zero: 5,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Clay tile and asbestos shingle on wood sheathing.	0	100	Fire and blast	
Trusses: Wood, presumably triangular.	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete on earth.	0	20	Debris	
Foundation: Concrete	10	0	Blast	
Exterior walls: Wood	0	100	Fire and blast	
Windows: Wood sash	0	100	do	
Contents: Machinery	0	0		

Remarks: Nothing left but floor and column bases—evidence of intense fire. Photo 189.

# DAMAGE ANALYSIS

Dimensions: 42 by 16 feet over all.  
Ground floor area: 660 square feet.  
Total Area: 660 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 36.  
Building No. 2.  
Occupancy: Transformers, water.  
Building Type: Small, wood-frame (D).  
Fire classification: Combustible (C).  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: NA	0	100	Blast	Roof entirely gone. Do.
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Earth and concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Wood, brick, and concrete.	0	100	Blast	
Contents: Transformers and water	0	0		

Remarks: Actually 2 small buildings, 1 housing transformers, the other being a roofed water basin. Photo 190.

# DAMAGE ANALYSIS

Dimensions: 24 by 16 feet.  
Ground floor area: 384 square feet.  
Total area: 384 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 36.  
Building No. 3.  
Occupancy: Mortar mixing (?).  
Building type: Small, wood-frame (D).  
Fire classification: Combustible (C).  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	100	Blast	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Wood	0	100	Blast	
Windows: NA	0	100	do	
Contents: Mortar-mixing machinery (?)	0	0		

Remarks: Completely demolished wooden shack.

# DAMAGE ANALYSIS

Dimensions: Base 8-foot diameter; stack 6-foot diameter.  
Ground floor area: 50 square feet.  
Total area: 50 square feet.  
Number of floors: 1.  
Eave height: 80 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 4.  
Occupancy: Stack for Building 7.  
Building type: Steel smokestack (S).  
Fire classification: Noncombustible (N).  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Foundation: Reinforced concrete	0	0		
Exterior walls: Steel plate	0	0		

# DAMAGE ANALYSIS

Dimensions: 22 by 20 feet.  
Ground floor area: 440 square feet.  
Total area: 440 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 5.  
Occupancy: Toilets.  
Building type: Small, wood-frame (D).  
Fire classification: Combustible (C).  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood; monitor vent.	0	100	Blast	
Trusses: Wood	100	0	do.	
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls:				
Concrete lower 4 feet	0	0		
Wood upper 8 feet	100	0	Blast	
Windows: Wood sash	0	100	do.	

Remarks: No fire; building collapsed toward south.

# DAMAGE ANALYSIS

Dimensions: 80 by 40 feet.  
Ground floor area: 3,200 square feet.  
Total area: 3,200 square feet.  
Number of floors: 1.  
Eave height: 32 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 6.  
Occupancy: Steam plant.  
Building type: Mill, 1 wood bent (D).  
Fire classification: Combustible (C).  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	100	Blast and fire	
Trusses: Steel, light	100	0	Blast	
Columns: Wood	100	0	Blast and fire	
First floor: Concrete	0	0		
Foundation: Concrete				
Exterior walls: Wood	0	100	Blast and fire	
Windows: Wood sash	0	100	do.	
Contents: Machinery	0	0		

# DAMAGE ANALYSIS

Dimensions: 40 by 28 feet.  
Ground floor area: 1,120 square feet.  
Total area: 1,120 square feet.  
Number of floors: 1.  
Eave height: 10 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 7.  
Occupancy: Compressors.  
Building type: Wood-frame (D).  
Fire classification: C.  
Ground zero: 5,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast and fire	
Trusses: Wood	100	0	do.	
Columns: Wood	100	0	do.	
First floor: Concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Wood	0	100	Blast and fire	
Contents: Switch gear; compressors	0	0		Badly damaged.

Remarks: Compressors protected by reinforced concrete structure, with 16-inch walls, which protected them when building burned.

# DAMAGE ANALYSIS

Dimensions: 354 by 374 feet.  
Ground floor area: 132,300 square feet.  
Total area: 132,300 square feet.  
Number of floors: 1.  
Eave height: 50 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 8.  
Occupancy: Heavy machining.  
Building type: Heavy steel-frame (B1).  
Fire classification: Noncombustible (N).  
Ground zero: 5,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal and asbestos on wood purlins	0	100	Blast and fire	Roofing off; purlins 60 percent gone. Photos 191 and 194.
Trusses: Steel	0	0		
Columns: Heavy steel	5	0	Blast	
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	100	Blast	Slightly bowed in (south in northernmost row only). Photo 197.
Interior walls: Scattered blast walls, concrete, 7 ft high	0	0		
Windows: Steel sash	0	100	do.	
Contents: Traveling cranes; machinery	0	10	do.	

Remarks: Practically no structural damage; some fire evidence. Photos 191 to 194, inclusive, 197, 198, 199, 201, and 202.

# DAMAGE ANALYSIS

Dimensions: 256 by 42 feet.  
Ground floor area: 10,800 square feet.  
Total area: 10,800 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 10 feet.  
Group 36.

Building No. 9.  
Occupancy: Parts stock room.  
Building type: Mill, 1 bent brick construction (A2.3).  
Fire classification: C.  
Ground zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Clay tile in mud on wood sheathing and purlins.	0	100	Blast	
Trusses: Wood	100	0	do	
First floor: Concrete	0	10	Debris	
Foundation: Concrete or brick	0	0		
Exterior walls: Brick, load-bearing	90	0	Blast	
Interior walls: Brick	0	100	do	
Windows: Wood sash	0	100	do	
Contents: Parts stock	0	0		

Remarks: Almost completely demolished. No fire.

# DAMAGE ANALYSIS

Dimensions: 48 by 32 feet.  
Ground floor area: 1,530 square feet.  
Total area: 1,530 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 10 feet.  
Group 36.

Building No. 10.  
Occupancy: Electric switchboards.  
Building type: Reinforced concrete frame; small (D).  
Fire classification: R.  
Ground zero: 5,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced-concrete slab, pitched.	0	0		
Trusses: Concrete with steel lower chord and verticals.	0	0		
Columns: Reinforced concrete 16 by 25 inches.	0	0		
First floor: Reinforced concrete	0	0		
Foundation: Reinforced concrete	0	0		
Exterior walls: Reinforced concrete 10 inches.	0	0		
Interior walls: None				
Windows: No glass—metal fire shutters only.	0	50	Blast	Bowed and sprung.
Contents: Switchboards	0	0		

# DAMAGE ANALYSIS

Dimensions: See plot plan.  
Ground floor area: 12,400 square feet.  
Total area: 12,400 square feet.  
Number of floors: 1.  
Eave height: NA.  
Mean elevation: 10 feet.

Group 36.  
Building Nos.: 11, 12, 13, and 14.  
Occupancy: Storage.  
Building type: Wall-bearing, 1-story brick (D).  
Fire classification: C.  
Ground zero: 5,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Clay tile in mud on wood sheathing and purlins.	0	100	Blast	
Trusses: Wood	100	0	do	
First floor: Concrete	0	10	Debris	
Foundation: Concrete or brick	0	0		
Exterior walls: Brick, load-bearing	90	0	Blast	
Interior walls: Brick	0	100	do	
Windows: Wood sash	0	100	do	
Contents: Miscellaneous storage	0	0		

Remarks: Almost completely demolished. No fire. Photos 188 and 195.

# DAMAGE ANALYSIS

Dimensions: 120 by 20 feet.  
Ground floor area: 2,400 square feet.  
Total area: 2,400 square feet.  
Number of floors: 1.  
Eave height: 10 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 15.  
Occupancy: Small hand shop or storage.  
Building type: Wood-frame, small (D).  
Fire classification: C.  
Ground zero: 5,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood shingles, sheathing, rafters, purlins.	0	100	Blast	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
First floor: Concrete	0	10	Debris	
Foundation: Concrete	0	0		
Exterior walls: Wood	0	100	Blast	
Windows: Wood sash	0	100	do	
Contents: Not known	0	0		

Remarks: Completely demolished. No fire.

# DAMAGE ANALYSIS

Dimensions: 360 by 186 feet over all.  
Ground floor area: 58,000 square feet.  
Total area: 58,000 square feet.  
Number of floors: 1.  
Eave height: 28 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 16.  
Occupancy: Heat treatment.  
Building type: Mill, 5 bents; steel frame (B).  
Fire classification: N.  
Ground zero: 5,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos on wood purlins.	0	100	Blast	Purlins 60 percent gone.
Trusses: Steel.	10	0	do.	Photo 200.
Columns: Steel.	0	0		
First floor: Earth, with concrete walkways.	0	10	Debris	
Foundation: Concrete.	0	0		
Exterior walls: Corrugated metal.	0	100	Blast	
Windows: Steel sash.	0	100	do.	
Contents: Heat treatment equipment.	0	5	Weather	

Remarks: No fire. Photo 200.

# DAMAGE ANALYSIS

Dimensions: 144 by 40 feet over all.  
Ground floor area: 5,400 square feet.  
Total area: 5,400 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 17.  
Occupancy: Wood shop.  
Building type: Mill, 2 bents; brick (D).  
Fire classification: C.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood sheathing, rafters and purlins.	0	100	Blast	
Trusses: Wood.	80	0	do.	
Columns: (Interior) wood, 7 by 7 inches.	10	90	do.	All columns canted.
First floor: Wood.	0	20	Debris	
Foundation: Concrete or brick.	0	0		
Exterior walls: 12-inch brick, load-bearing.	100	0	Blast	North wall collapsed inward; south wall still standing but leaning 1 foot outward.
Windows: Not known.	0	100	do.	
Contents: Woodworking equipment.	0	0		

Remarks: Photo 196.

# DAMAGE ANALYSIS

Dimensions: 110 by 32 feet.  
Ground floor area: 3,500 square feet.  
Total area: 3,500 square feet.  
Number of floors: 1.  
Eave height: 13 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 18.  
Occupancy: Boiler and generators.  
Building type: Wall-bearing, 1-story brick (D).  
Fire classification: N.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal on wood purlins.	0	100	Blast	Roofing gone; purlins 60 percent gone.
Trusses: Steel.	0	0		
Columns: Brick pilasters 20 to 30 inches wide, projecting 13 inches.	0	0		Considered part of exterior walls (see below).
First floor: Concrete.	0	0		
Basement: None.	0	0		
Foundation: Concrete.	40	0	Blast	Cracked but standing.
Exterior walls: Brick, 15 inches thick including cement plaster on both sides.	0	0		
Interior walls: Same as exterior.	0	0		
Windows: Steel sash.	0	100	Blast	Glass out, sash distorted.
Finish: Cement plaster on walls.	0	40	do.	Cracked and scaled.

Remarks: No fire. Generators protected by reinforced concrete blast blocks 7 feet high. Photo 187.

# DAMAGE ANALYSIS

Dimensions: 145 by 54 feet over all.  
Ground floor area: 6,700 square feet.  
Total area: 6,700 square feet.  
Number of floors: 1.  
Eave height: 13 feet.  
Mean elevation: 10 feet.

Group 36.  
Building No. 19.  
Occupancy: Garage, kitchen, and cafeteria.  
Building type: Mill, 2- and 3-bent wood (D).  
Fire classification: C.  
Ground zero: 4,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood sheathing.	0	100	Fire and blast	
Trusses: Wood.	100	0	do.	
Columns: Wood (interior only).	100	0	do.	
First floor: Concrete.	0	0		
Foundation: Concrete.	0	0		
Exterior walls: Brick, 15 inches, including stucco; pilasters 14 inches wide, projecting 9 inches.	90	0	Blast	
Interior walls: 12-inch brick.	0	0		
Windows: Steel sash.	0	100	Blast	

Remarks: Almost complete collapse, with internal fire. Photo 187.

# DAMAGE ANALYSIS

Dimensions: 226 by 36 feet; 184 by 36 feet.  
Ground floor area: 14,700 square feet.  
Total area: 29,400 square feet.  
Number of floors: 2.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 36.  
Building Nos. 20 and 21.  
Occupancy: Unknown—probably stores.  
Building type: 2-story, wood-frame (E2).  
Fire classification: C.  
Ground zero: 5,000 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Tile in mud on wood sheathing, rafters, and purlins.	0	100	Blast	
Trusses: Wood	100	0	do	
Columns: Wood	100	0	do	
Second floor: Wood	0	10	Debris	
First floor: Concrete	0	0		
Foundation: Concrete	0	100	Blast	
Exterior walls: Wood	0	100	do	
Interior walls: Wood	0	100	do	
Windows: Wood sash	0	0		
Finish: Not known	0	0		
Contents: Not known	0	0		

Remarks: Complete collapse. No fire. Partly cleared since attack.

# DAMAGE ANALYSIS

Dimensions: 34 by 44 feet.  
Ground floor area: 1,500 square feet.  
Total area: 1,500 square feet.  
Number of floors: 1.  
Eave height: 10 feet, 9 inches.  
Mean elevation: 10 feet.

Group 36.  
Building No. 22.  
Occupancy: Garage (?).  
Building type: Wall-bearing, 1-story brick (D).  
Fire classification: N.  
Ground zero: 4,900 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos on wood purlins.	0	100	Blast	Purlins 50 percent gone.
Trusses: Steel	100	0	do	Crippled at north end.
Columns: None (see exterior walls).	0	0		
First floor: Concrete	0	0		
Foundation: Concrete or brick.	50	0	Blast	Cracked, still standing.
Exterior walls: 12-inch brick, plastered both sides; pilasters 15 inches wide projecting 14 inches.	0	100	do	
Windows: Wood sash	0	50	do	Cracked.
Finish: Cement plaster	0	0		
Contents: Not known	0	0		

Remarks: No fire.

# DAMAGE ANALYSIS

Dimensions: 120 by 100 feet over all.  
Ground floor area: 7,900 square feet.  
Total area: NA; probably 15,800 square feet.  
Number of floors: NA; probably 2.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 36.  
Building No. 23.  
Occupancy: Offices.  
Building type: 2-story, wood-frame (E2).  
Fire classification: G.  
Ground zero: 5,100 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: NA	0	100	Fire and blast	
Trusses: NA; probably wood	100	0	do	
Columns: NA; probably wood	100	0	do	
Second floor: NA; probably wood	100	0	do	
First floor: Concrete	0	20	Debris	
Foundation: Concrete	0	0		
Exterior walls: NA; probably wood	0	100	Fire and blast	
Interior walls: NA; probably wood	0	100	do	
Windows: NA; probably wood sash	0	100	do	
Finish: NA; probably plaster with wood trim	0	100	do	

Remarks: Building completely down and cleared away except first floor and foundations. Indications of fire damage.

# 14. Kyushu Electric Power Plant—Group 39

a. This was a typical generating station consisting of a boiler room and a turbine room. It was located 6,700 feet south of GZ. The building covered a total plan area of approximately 12,160 square feet, and was of brick-wall and steel-truss construction.

b. The building suffered considerable structural damage. The light steel roof trusses collapsed, and the north and east brick walls were demolished. The reinforced-concrete stack was practically undamaged.

c. Damage to this plant is shown on Photos 203 to 210, inclusive, and on the following damage analysis sheet.

## DAMAGE ANALYSIS

Dimensions: 164 by 94 feet.  
Ground floor area: 12,160 square feet.  
Total area: 12,160 square feet.  
Number of floors: 1.  
Eave height: 35 feet.  
Mean elevation: 10 feet.

Group 39.  
Building No. 1.  
Occupancy: Generating station.  
Building type: Steel and brick (B2).  
Fire classification: C.  
Ground zero: 6,700 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Wood—Turbine Rm; corrugated iron—Boiler Rm.	0	100	Blast	
Trusses: Steel	80	0	do	Photos 203, 204, 205, 208, and 210.
Columns: Brick	75	0	do	
First floor: Ground floor—reinforced concrete; turbine Rm Fl—reinforced concrete.	50	0	do	
Foundation: Reinforced concrete	0	0		
Exterior walls: 24-, 26-, and 28-inch brick.	75	0	Blast	Photos 205, 206, 207, and 208.
Windows: Wood sash	100	0	do	
Contents: Crane, turbine, and boiler	75	0	do	Boiler only. Photos 203, 204, 205, 209, and 210.

Remarks: Photos 203 to 210, inclusive.

# 15. Standard-Vacuum Oil Works—Group 40

a. Unimportant structurally, this group comprised 3 storage tanks for oil or gasoline and 11 buildings containing additional storage space and buildings containing additional storage space and minor sheet-metal-working facilities. It was about 6,400 feet, slightly east of south, from GZ. It covered approximately 35,000 square feet of plan area, of which about 1,000 square feet consisted of the tanks which were of steel, with a storage capacity of about 170,000 gallons. All buildings were small, single-story, and mostly combustible, of wood-frame or load-bearing-wall construction, but with parts of some of them noncombustible and framed of light steel. The following table lists buildings and tanks.

b. In general, the tanks were slightly damaged but the buildings were almost entirely destroyed by blast and fire. Tanks 4 and 5 were vertical, and Tank 6 was horizontal. Tank 6 was wholly undamaged. The other two were somewhat crushed in on top and on the north side by blast, causing failure of a few riveted seams, but contents (if any at ZH) apparently were not ignited and total damage was minor.

c. Parts of three buildings (Nos. 1, 2, and 11), constituting 29 percent of building plan area, were of light steel framing, surfaced with corrugated

metal. This part of Building 2 sustained superficial damage and slight structural damage from blast alone, although its inflammable contents (rope and fiber) were burned. The other two were heavily damaged structurally by blast and fire.

d. Four buildings (Nos. 3, 7, 8, and 10) and parts of three others (Nos. 1, 2, and 11), totaling 27 percent of building plan area, had load-bearing brick walls with noncombustible steel-trussed roofs in Buildings 3 and 7, and combustible steel-trussed roofs in other cases. This part of Building 2 was a very small toilet room and escaped damage. Buildings 3, 7, and 10 were structurally damaged by blast from blast and fire, and total fire damage to contents.

e. Four buildings (Nos. 9, 12, 13, and 14) and parts of two others (Nos. 2 and 11), totaling 44 percent of building plan area, were wood-frame and combustible. All suffered practically total structural damage: Buildings 9, 11, and 14 from blast and fire, the others from blast only.

f. Fire protection within the group consisted of two yard hydrants with about 150 feet of 2-inch linen hose; a foam-generating system with outlets in the three tanks and along the bulkhead; concrete dikes built around the tanks; sand boxes; small

static water tanks; and foam extinguishers. The adjacent harbor provided an unlimited water supply.

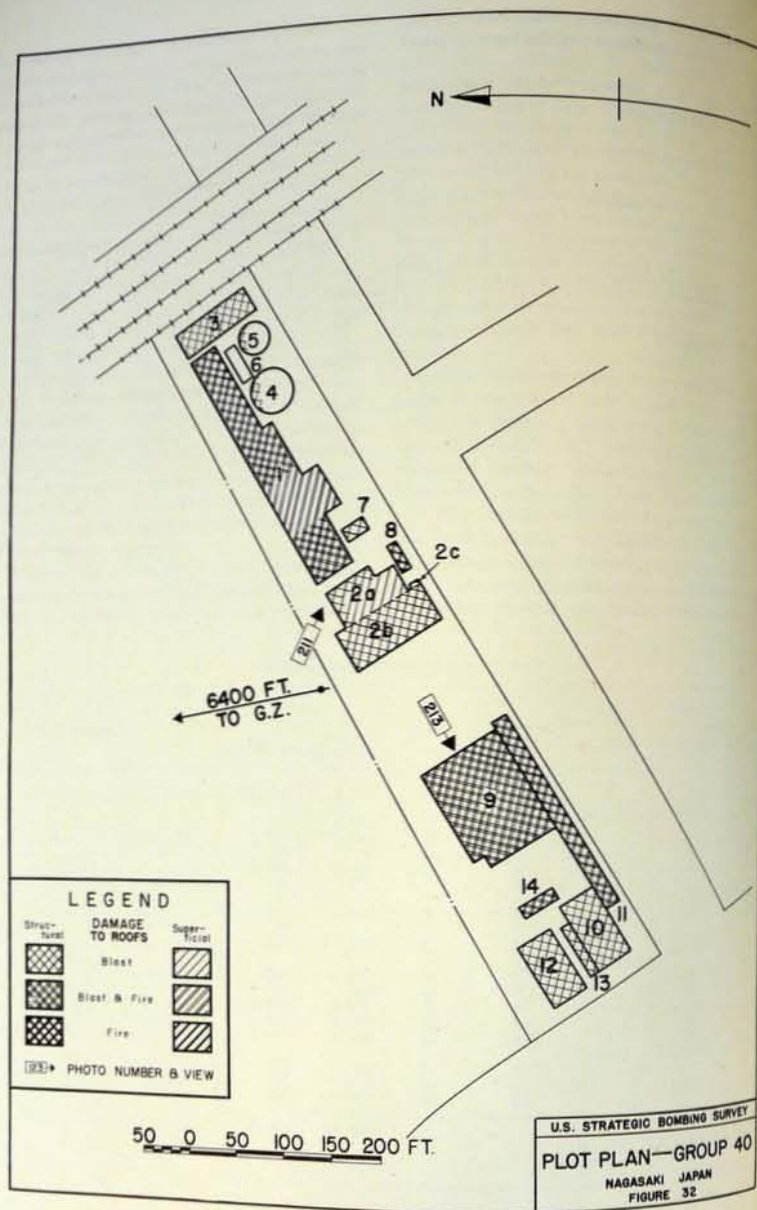
g. Following is a summary of fire damage to buildings and contents:

Building No.	Occupancy	Fire class	Estimated damage			
			Blast and fire, buildings		Fire, contents	
			Superficial	Structural		
1.	Shop and storage	N&C	Total	Serious	Total	Do.
2a.	Storage	N	Serious	Slight	Do.	Do.
3.	Office	C	Total	Serious	Do.	Do.
7.	Storage	N&C	do.	Total	Do.	Do.
8.	do.	C	do.	do.	Do.	Do.
11.	do.	C	do.	do.	Do.	Do.
14.	do.	C	do.	do.	Do.	Do.

h. Further information regarding the construction of the buildings in this group and the damage sustained by them will be found in Photos 211 through 216, in Figure 32, and on the damage analysis sheets immediately following the figure.

Building classification—Group 40

Building No.	Area		Type	Fire class	Construction		
	Plan (square feet)	Total (square feet)			Steel frame	Load-bearing wall	Roof
1.	9,124	9,124	D	N&C	X (part)	X (part)	
2a.	1,884	1,884	D	N	X		
3.	3,600	3,600	D	C			X
4.	40	40	D	C		X	
5.	2,090	2,090	D	N		X	
6.	616	616	S	N	X (tank)		
7.	200	200	S	N	X (tank)		
8.	225	225	S	N	X (tank)		
9.	324	324	D	N		X	
10.	589	589	D	C		X	X
11.	9,350	9,350	D	C		X	X
12.	2,812	2,812	D	C		X	X
13.	3,000	3,000	D	N&C	X (part)	X (part)	X (part)
14.	NA	NA	D	C			X
15.	550	550	D	C			X
16.	400	400	D	C			X
Total.	34,804	34,804			1 3 tanks 2 in part	5 2 in part	5 1 in part



## DAMAGE ANALYSIS

Dimensions: 260 by 59 feet over all.  
Ground floor area: 9,124 square feet.  
Total area: 9,124 square feet.  
Number of floors: 1.  
Eave height: 13 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 1.  
Occupancy: Shop and storage (drums of oil or gas).  
Building type: Steel and brick, 1 story (D).  
Fire classification: Mixed (part N, part C).  
Ground zero: 6,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: West quarter: Asbestos shingles on wood sheathing, rafters and purlins; remainder CGI on light steel framing. Trusses: Steel—rather heavy in west quarter; very light in remainder.	0	100	Blast and fire	No fire in west half, but roof blown off; intense contents fire in east half. Photo 212.
Columns: None in west quarter; 6-inch steel I-sections in remainder.	75	0	do	Knocked down in west quarter; undamaged in next quarter. Down and badly warped in east half. Photo 212.
First floor: Concrete on earth. Foundation: Concrete.	80	0	do	Down and badly warped in east half. Standing (but some distorted) in next quarter.
Exterior walls: West quarter, 12-inch brick with 4- by 12-inch pilasters at each truss. Remainder CGI on light steel framing.	0	10	Debris	
	0	0		
	25	75	Blast and fire	West quarter; collapsed southward, no fire; next quarter stripped by blast, no fire; remainder completely wrecked by blast and fire.
Interior walls: One CGI partition at midpoint, appearing in photo 212.	0	80	Fire	Still standing but warped by heat.
Windows: Steel sash.	0	100	Blast and fire	
Contents: Can fabrication machinery in west half; drums of oil or gasoline in east half.	0	75	Fire and debris	Oil or fuel completely consumed, machinery about half destroyed.

Remarks: Photo 212.

# DAMAGE ANALYSIS

Dimensions: 65 by 33 feet over all.  
Ground floor area: 1,884 square feet.  
Total area: 1,884 square feet.  
Number of floors: 1.  
Eave height: 15 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 2a (2b, 2c, see Remarks below).  
Occupancy: Storage.  
Building type: 1-story steel warehouse (D).  
Fire classification: Noncombustible.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: CGI on steel L-purlins	0	100	Blast	Partly stripped, partly ened and distorted. Photo 211.
Trusses: Light steel (single angle members)	15	0	do	In place but distorted.
Columns: Steel—6.5- by 3-inch I's; 10 3½- by 3½- by ¾-inch L's; 5 2½- by 3½- by ¾-inch L's; also 3½-inch OD pipe columns carrying 5-inch electric hoist rails.	30	0	do	In place but distorted. Photo 215.
First floor: Concrete on earth	0	0		
Foundation: 15- by 15-inch concrete piers at columns.	0	0		
Exterior walls: CGI on light steel framing.	0	60	Blast	Stripped and loosened.
Contents: Metal can parts; rope, fiber, etc.	0	100	Fire	

Remarks: Photos 211 and 215. Building 2b was about 90 by 40 feet, 1 story, wood-frame, shingled; contained sheet-metal-working machinery; completely burned or blasted down and cleared away. Building 2c was toilet and lavatory, 1 story, 5 by 8 foot, with 8-inch brick walls.

# DAMAGE ANALYSIS

Dimensions: 95 by 22 feet.  
Ground floor area: 2,090 square feet.  
Total area: 2,090 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 3.  
Occupancy: Storage.  
Building type: 1-story brick wall warehouse (D).  
Fire classification: Noncombustible.  
Ground zero: 6,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: CGI on steel L-purlins	0	100	Blast	Demolished.
Trusses: Simple, steel; 3- by 3-inch L-members, bolted to walls.	100	0	do	Crippled and fallen.
First floor: Concrete on earth.	0	0		
Foundation: Concrete or brick footings.	0	0		
Exterior walls: 12-inch brick; 4- by 16-inch pilasters 10 feet by 6 inches o. c.	60	0	Blast	North and east walls almost entirely wrecked; south wall cracked and partly wrecked; west wall almost intact.
Windows: Bars and fire shutters only—no glass.	0	100		Shutters blown off.
Contents: NA.				

# DAMAGE ANALYSIS

Dimensions: 28 feet diameter.  
Ground floor area: 616 square feet.  
Total area: 616 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 4.  
Occupancy: Gasoline or oil storage.  
Building type: Steel tank, vertical (S).  
Fire classification: Noncombustible.  
Ground zero: 6,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Conical, 2 feet high. ½-inch steel plate.	0	10	Blast	Dented; no real damage.
Trusses: Light steel	0	0		
First floor: Presumably steel plate	0	0		
Foundation: Reinforced-concrete slab.	0	0		
Exterior walls: ½-inch steel plate	10	20	Blast	Bowed in on north side, maximum of 4 feet. A few riveted seams failed.
Contents: Gasoline or oil	0	0		

# DAMAGE ANALYSIS

Dimensions: 16 feet diameter.  
Ground floor area: 200 square feet.  
Total area: 200 square feet.  
Number of floors: 1.  
Eave height: 21 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 5.  
Occupancy: Gasoline or oil storage.  
Building type: Steel tank, vertical (S).  
Fire classification: Noncombustible.  
Ground zero: 6,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Conical, 1 foot high; 1/4-inch steel plate, radial riveted seams.	100	0	Blast	Bowed in by blast; rivets failed; seams opened.
Columns: 1 at center, built up of several steel angles.	0	0		
First floor: Presumably steel plate.	0	0		
Foundation: Brick wall to height of 6 feet above grade.	0	0		
Exterior walls: Steel plate, probably 1/4-inch.	0	0		Bowed in; no seams failed.
Contents: Gasoline or oil.	0	0		

# DAMAGE ANALYSIS

Dimensions: 25 feet long, 9 feet diameter.  
Ground floor area: 225 square feet.  
Total area: 225 square feet.  
Number of floors: 1.  
Eave height: 11 feet over all.  
Mean elevation: 10 feet.

Group 40.  
Building No. 6.  
Occupancy: Gasoline or oil storage.  
Building type: Steel tank, horizontal (S).  
Fire classification: Noncombustible.  
Ground zero: 6,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: 1/4-inch steel plate.	0	0		
First floor: 1/4-inch steel plate.	0	0		
Foundation: Reinforced concrete.	0	0		
Exterior walls: 1/4-inch steel plate.	0	0		
Contents: Gasoline or oil.	0	0		

# DAMAGE ANALYSIS

Dimensions: 27 by 12 feet.  
Ground floor area: 324 square feet.  
Total area: 324 square feet.  
Number of floors: 1.  
Eave height: 9 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 7.  
Occupancy: Unknown.  
Building type: 1-story, wall-bearing brick (D).  
Fire classification: Noncombustible.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos on steel L purlins.	0	100	Blast	
Trusses: Light pressed steel, welded.	100	0	do.	Knocked down and collapsed laterally.
First floor: Concrete on earth.	0	0		
Foundation: Concrete or brick footings.	0	0		
Exterior walls: 8-inch brick.	10	0	Blast	
Windows: Steel sash.	0	100	do.	Glass out, sashes bent.
Contents: NA.				

# DAMAGE ANALYSIS

Dimensions: 31 by 19 feet.  
Ground floor area: 589 square feet.  
Total area: 589 square feet.  
Number of floors: 1.  
Eave height: 13 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 8.  
Occupancy: Office.  
Building type: 1-story, wall-bearing brick (D).  
Fire classification: Combustible.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos.	0	100	Fire and blast	Completely demolished.
Trusses: Wood.	100	0	do.	Do.
First floor: Wood, on wood joists.	100	0	Fire	Cracks.
Foundation: Brick, 16 inches thick; also 8- by 8-inch brick piers.	10	0	Fire and blast	
Exterior walls: Brick, 12 inches thick.	10	0	do.	Do.
Windows: Wood sash.	0	100	do.	
Finish: Plaster, wood trim.	0	100	Fire	
Contents: Office furniture, etc.	0	100	do.	

Remarks: Photo 216.

# DAMAGE ANALYSIS

Dimensions: About 110 by 85 feet.  
Ground floor area: About 9,350 square feet.  
Total area: About 9,350 square feet.  
Number of floors: 1, presumably.  
Eave height: NA.  
Mean elevation: 10 feet.

Group 40.  
Building No. 9.  
Occupancy: Unknown.  
Building type: 1-story, wood-frame (D).  
Fire classification: Combustible.  
Ground zero: 6,400 feet.

This was apparently a group of immediately adjacent buildings, or a building with several additions. It was completely destroyed by blast and fire. No details known.

# DAMAGE ANALYSIS

Dimensions: 74 by 38 feet.  
Ground floor area: 2,812 square feet.  
Total area: 2,812 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 10.  
Occupancy: Warehouse.  
Building type: 1-story wall-bearing brick (D).  
Fire classification: Combustible.  
Ground zero: 6,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile and bamboo and mud on wood purlins.	0	100	Blast	Part of west wall still standing, full height; otherwise demolished.
Trusses: Wood.	100	0	do.	
First floor: Covered by debris; presumably concrete on earth.	0	0	Debris	
Foundation: Concrete footings.	0	0		
Exterior walls: 12-inch brick; 4- by 24-inch pilasters at trusses.	90	0	Blast	
Contents: NA.				

Remarks: Photo 214.

# DAMAGE ANALYSIS

Dimensions: About 200 by 15 feet.  
Ground floor area: About 3,000 square feet.  
Total area: 3,000 square feet.  
Number of floors: 1.  
Eave height: NA.  
Mean elevation: 10 feet.

Group 40.  
Building No. 11.  
Occupancy: Loading or storage sheds.  
Building type: 1-story sheds (D).  
Fire classification: Mixed (N and C).  
Ground zero: 6,500 feet.

This was a series of small sheds of varying construction, 100 percent demolished. West end (about 60 feet) was of light steel framing covered with corrugated iron; no fire damage. Remainder shows steel but some brick, some wood, apparently tile roofs, consumed by fire.

# DAMAGE ANALYSIS

Dimensions: Not known.  
Ground floor area: Not known.  
Total area: Not known.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 40.  
Building No. 12.  
Occupancy: Storage (?).  
Building type: 1-story shed (D).  
Fire classification: Combustible.  
Ground zero: 6,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood.	0	100	Blast	See remarks.
Trusses: Wood.	100	0	do.	Do.
Columns: Wood.	100	0	do.	Do.
First floor: Part wood, part concrete.	0	NA		Do.
Foundation: Low stone wall.	0	0		Do.
Exterior walls: Wood, if any.	0	100	Blast	Do.
Windows: NA (probably none).	0	100	do.	Do.
Contents: NA.	0	NA		Do.

Remarks: Building completely demolished, no fire evidence. Impossible to determine dimensions or construction details.

# DAMAGE ANALYSIS

Dimensions: 50 by 11 feet.  
Ground floor area: 550 square feet.  
Total area: 550 square feet.  
Number of floors: 1.  
Eave height: 10 feet.  
Mean elevation: 10 feet.

Group 40.  
Building No. 13.  
Occupancy: Oil drum storage.  
Building type: Wooden shed (D).  
Fire classification: Combustible.  
Ground zero: 6,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: CGI on wood purlins.	0	100	Blast	Purlins $\frac{3}{4}$ gone.
Trusses: Wood, very simple.	67	0	do.	Canted but still standing.
Columns: Wood posts.	100	0	do.	
First floor: Concrete on earth.	0	0		
Foundation: Concrete.	0	0		
Contents: Oil drums (empty).	0	5	Debris	

Remarks: Structure canted toward southwest.

# DAMAGE ANALYSIS

Dimensions: About 40 by 10 feet.  
Ground floor area: About 400 square feet.  
Total area: 400 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group: 40.  
Building No. 14.  
Occupancy: Oil drum storage.  
Building type: Open shed (D).  
Fire classification: Combustible.  
Ground zero: 6,500 feet.

Construction	Damage		Cause	Description of damage
	Structural (per-cent)	Superficial (per-cent)		
Roof: Tile on wood	0	100	Fire and blast	Completely demolished.
Trusses: Wood	100	0	do	Do.
Columns: Wood	100	0	do	Do.
First floor: Concrete on earth	0	0		
Foundation: Concrete	0	0		
Contents: Oil drums (empty)	0	5	Fire and debris	

Remarks: Photo 214.

## 16. Yachiyo Machi Gas Works—Group 41

a. This group was used for the production and storage of illuminating gas and was located 6,600 feet south of GZ. The buildings were of the flimsiest Japanese construction and offered no resistance to blast and fire. The gas retorts, however, were of heavy brick construction, braced by 7-inch horizontal and 12-inch vertical buck-stays, and were built on a foundation of heavy reinforced-concrete piers. Comparatively little damage was suffered by the retorts but the buildings which housed them were demolished. The top holders of the gas tanks were ruptured but no damage was sustained by the water tanks (Fig. 33, and Photos 217 to 223).

b. Buildings damaged or destroyed by blast and fire were as follows:

(1) Building 3 was a one-story, combustible building occupied as a shop. Totally damaged by blast and fire.

(2) Building 6 was a one-story, wood structure, housing a record vault. It was constructed of reinforced concrete. The entire building excepting the record vault was totally damaged by blast and fire.

c. Cause of fire could not be determined.

d. Fire protection consisted of a public water supply system static tank and hand pumps, located just east of main highway.

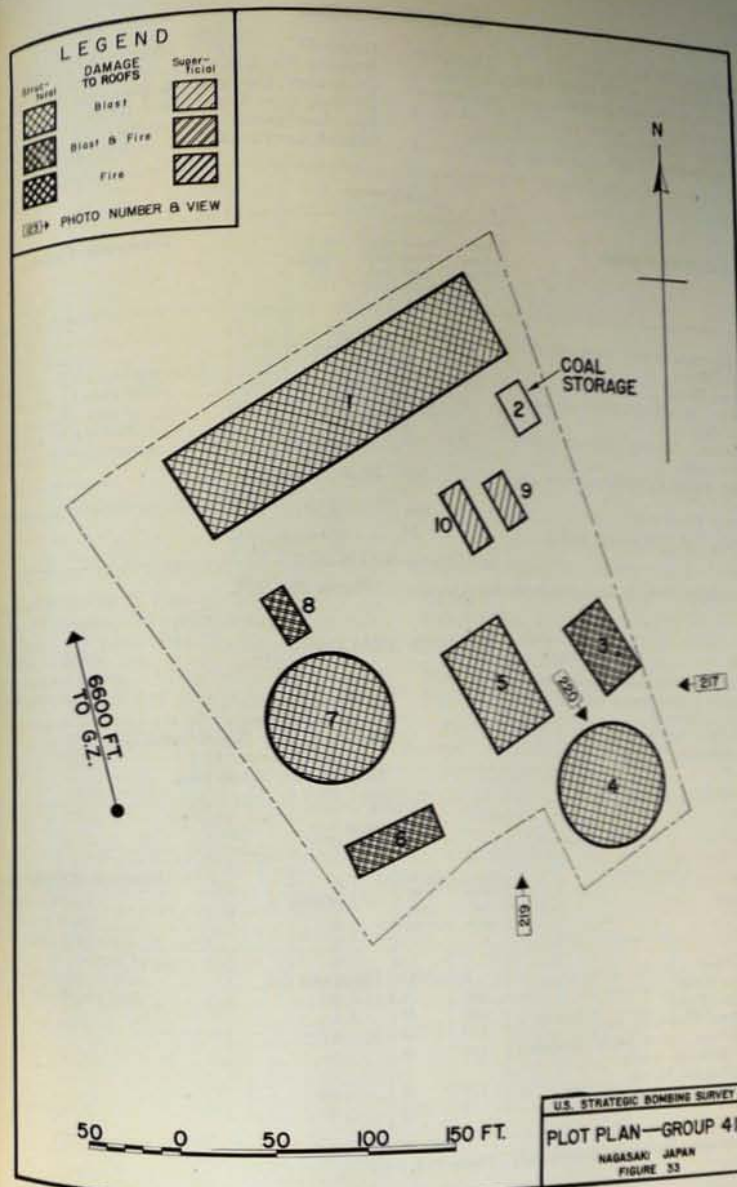
## e. Summary of Damage.

Building No.	Occupancy	Fire class	Estimated damage			
			Blast and fire, buildings		Fire, contents	
			Superficial	Structural		
3	Shop	C	Total	Total	Severe	
6	Office	C	do	do	Total	
Holders		N	do	Moderate	Do.	

## Building classification—Group 41

Building No.	Area		Type	Fire class	Cause of fire
	Plan (square feet)	Total (square feet)			
1	9,800	9,800	D	C	X
2 <sup>1</sup>					
3	6,000	6,000	D	C	X <sup>2</sup>
6					
8					
4 <sup>2</sup>	2,650	2,650	D	C	X
5					
7 <sup>1</sup>	450	450	D	C	X
9	570	570	D	C	X
10					
Total	19,470	19,470			

<sup>1</sup> Coal-storage space.  
<sup>2</sup> Gas holder.



# DAMAGE ANALYSIS

Dimensions: 195 by 50 feet.  
Ground floor area: 9,800 square feet.  
Total area: 9,800 square feet.  
Number of floors: 1.  
Eave height: Unknown.  
Mean elevation: 10 feet.

Group 41.  
Building No. 1.  
Occupancy: Gas retort shelter.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood.....	0	100	Blast.....	
Trusses: Wood.....	100	0	do.....	
Columns: Wood.....	100	0	do.....	
First floor: 8-inch reinforced concrete slab.....	0	0		
Foundation: 12- by 12-inch reinforced posts.....	0	0		
Exterior walls: Corrugated iron on wood.....	0	100	Blast.....	
Windows: Wood sash.....	0	100	do.....	
Contents: Gas retorts and piping.....	0	20	do.....	

Remarks: Outside shelter completely destroyed. Photos 218, 221.

# DAMAGE ANALYSIS

Ground floor area: 6,000 square feet.  
Total area: 6,000 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 41.  
Building Nos. 3, 6, 8.  
Occupancy: Shops.  
Building type: Wood-frame (D).  
Fire classification: C.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood.....	0	100	Blast and fire.....	
Trusses: Wood.....	100	0	do.....	
Columns: Wood.....	100	0	do.....	
First floor: Wood.....	100	0	do.....	
Foundation: 8-inch brick (building 6). None for 3 or 8.....	100	0	do.....	
Exterior walls: Wood.....	100	0	do.....	
Windows: Wood sash.....	0	100	do.....	

Remarks: Buildings demolished. Photo 219.

# DAMAGE ANALYSIS

Dimensions: 63 by 42 feet.  
Ground floor area: 2,650 square feet.  
Total area: 2,650 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 10 feet.

Group 41.  
Building No. 5.  
Occupancy: Compressor building.  
Building type: Wood-frame (D).  
Fire classification: C.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood.....	0	100	Blast.....	
Trusses: Wood.....	100	0	do.....	
First floor: Concrete on earth.....	5	0	do.....	
Foundation: 8-inch brick.....	0	0		
Exterior walls: Stucco.....	0	100	Blast.....	
Windows: Wood sash.....	0	100	do.....	
Contents: Compressors.....	30	0	do.....	

Remarks: Superstructure completely destroyed.

# DAMAGE ANALYSIS

Dimensions: 30 by 15 feet.  
Ground floor area: 450 square feet.  
Total area: 450 square feet.  
Number of floors: 1.  
Eave height: 8 feet.  
Mean elevation: 10 feet.

Group 41.  
Building No. 9.  
Occupancy: Shop.  
Building type: Shed (D).  
Fire classification: C.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood.....	0	100	Blast.....	
Trusses: Wood.....	0	0		
Columns: Wood.....	0	0		
First floor: Concrete on earth.....	0	0		
Foundation: 8-inch brick.....	0	0		
Exterior walls: Wood.....	0	15	Blast.....	
Windows: Wood sash.....	0	100	do.....	

# DAMAGE ANALYSIS

Dimensions: 38 by 15 feet.  
Ground floor area: 570 square feet.  
Total area: 570 square feet.  
Number of floors: 1.  
Eave height: 8 feet.  
Mean elevation: 10 feet.

Group 41.  
Building No. 10.  
Occupancy: Ash storage.  
Building type: Shed (D).  
Fire classification: C.  
Ground zero: 6,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	
Trusses: Wood	0	0		
Columns: Wood	0	0		
First floor: Brick	0	0		
Foundation: 8-inch brick	0	100	Blast	
Exterior walls: Corrugated asbestos	0	100	do.	
Windows: Wood sash	0	100		

## 17. Nagasaki Station and Freight Yard—Groups 44 and 45.

a. This group of buildings and installations was located approximately 8,000 feet south of GZ near the head of Nagasaki Harbor. It consisted of 6 principal buildings and 2 long narrow loading platforms. All of the structures except one (Building 6) were of wood construction. Building 6 was a steel-frame structure used for an engine repair shop. The only two-story structure (Building 1) contained station offices, waiting and baggage rooms. The total plan area covered by the buildings was approximately 34,300 square feet. The various building areas and types were as follows:

Building classification—Groups 44 and 45

Building No.	Area		Type	Fire Class	Construction	
	Plan (square feet)	Total (square feet)			Steel frame	Wood
1	4,440	8,880	EI	C	X	
2	2,720	2,720	D	C		X
3	4,896	4,896	D	C		X
4	11,016	11,016	D	C		X
5	1,700	1,700	D	C		X
6	9,520	9,520	D	N	X	
Total	34,292	38,732			1	5

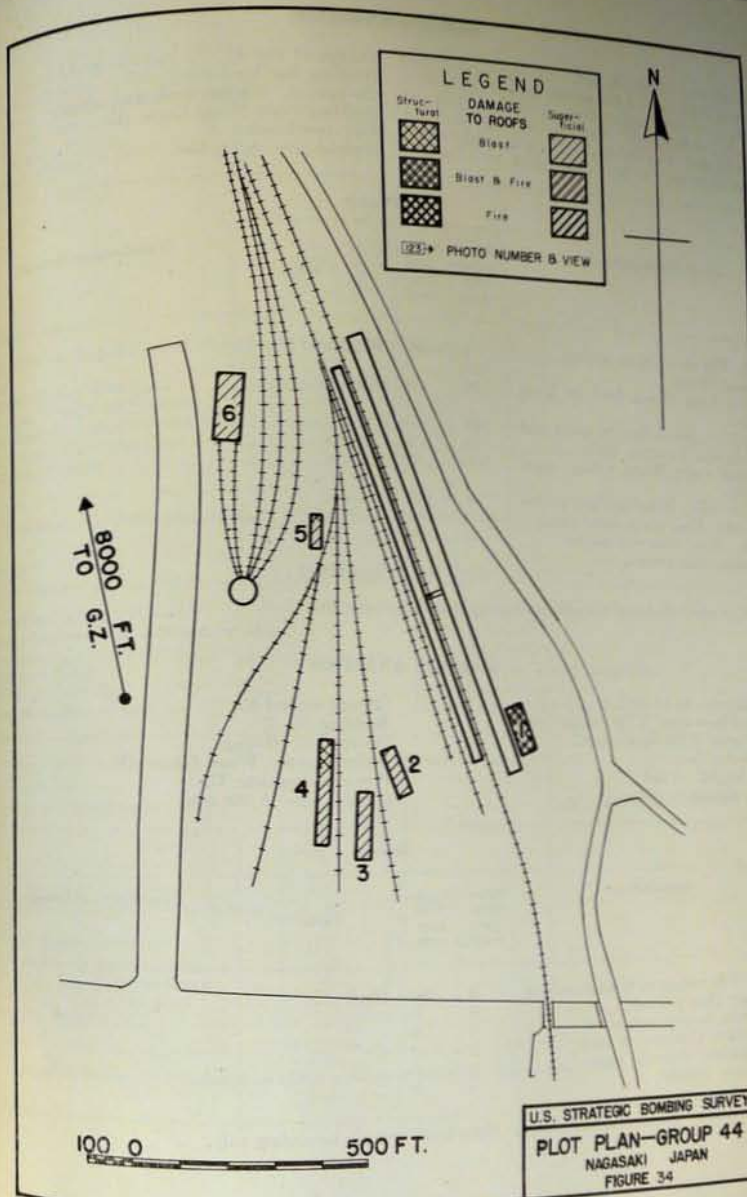
b. The steel-frame building (No. 6) sustained only superficial and minor damage to corrugated iron roofing and siding.

c. The northern portions of Buildings 4 and 5 were structurally damaged. The remaining portions of these buildings and the entire roof areas of Buildings 2 and 3 sustained superficial damage.

d. The greatest amount of damage in this group occurred in the two-story structure (Building 1) which was structurally damaged by blast and entirely consumed by fire, leaving only the foundation walls remaining. This fire was attributed to primary causes. The possibility of fire spread was considered negligible. The building caught on fire almost immediately after the blast and when the fire department reached the site within 8 minutes it was a mass of flames. At the time of the survey the site of Building 1 had been cleared of debris and temporary structures had been constructed on the loading platform for office use.

e. No data regarding fire protection could be obtained.

f. Further information regarding this group is given on the damage analysis sheets following the plot plan on Figure 34.



# DAMAGE ANALYSIS

Dimensions: 37 by 120 feet.  
Ground floor area: 4,440 square feet.  
Total area: 8,880 square feet.  
Number of floors: 2.  
Eave height: Not known.  
Mean elevation: 10 feet.

Groups 44 and 45.  
Building No. 1.  
Occupancy: Waiting room and office.  
Building type: Wood frame (E1).  
Fire classification: C.  
Ground zero: 8,200 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Tile on wood sheathing	0	100	Blast and fire	
Trusses: Wood	100	0	Blast and fire	
Second floor: Wood floor on wood joist	100	0	do	
First floor: Wood floor on wood joist	100	0	do	
Foundation: Concrete walls	75	0	do	
Exterior walls: Wood siding, wood frame	100	0	do	
Interior walls: Wood lath and plaster	0	100	do	
Windows: Plain glass, wood frame	0	100	do	
Finish: Wood trim and plaster	0	100	do	
Contents: Not known.				

Remarks: Building completely destroyed by blast and fire.

# DAMAGE ANALYSIS

Dimensions: 34 by 80 feet.  
Ground floor area: 2,720 square feet.  
Total area: 2,720 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 10 feet.

Groups 44 and 45.  
Building No. 2.  
Occupancy: Storage.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 8,200 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Tile roofing on wood sheathing	0	100	Blast	
Trusses: Heavy wood	0	0	do	
Columns: 6- by 6-inch wood	0	0	do	
First floor: Concrete on earth	0	0	do	
Foundation: Concrete piers	0	0	do	
Contents: Freight	0	0	do	

Remarks: No structural damage. Superficial damage to roofing only.

# DAMAGE ANALYSIS

Dimensions: 34 by 144 feet.  
Ground floor area: 4,896 square feet.  
Total area: 4,896 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 10 feet.

Group 44 and 45.  
Building No. 3.  
Occupancy: Storage.  
Building type: Wood frame (D).  
Fire classification: C.  
Ground zero: 8,200 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Tile roofing on wood sheathing	0	100	Blast	
Trusses: Heavy wood	0	0	do	
Columns: 6- by 6-inch wood	0	0	do	
First floor: Concrete on earth	0	0	do	
Foundation: Concrete piers	0	0	do	
Contents: Freight	0	0	do	

Remarks: No structural damage. Superficial damage to roofing only.

# DAMAGE ANALYSIS

Dimensions: 34 by 324 feet.  
Ground floor area: 11,016 square feet.  
Total area: 11,016 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 10 feet.

Group 44 and 45.  
Building No. 4.  
Occupancy: Storage.  
Building type: Wood-frame (D).  
Fire classification: C.  
Ground zero: 8,200 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Tile roofing on wood sheathing	0	100	Blast	
Trusses: Heavy wood	25	0	do	
Columns: 6- by 6-inch wood	25	0	do	
First floor: Concrete on earth	0	0	do	
Foundation: Concrete piers	0	0	do	
Contents: Freight	0	0	do	

Remarks: Structural damage to north section of building; this section removed.

# DAMAGE ANALYSIS

Dimensions: 20 by 85 feet.  
Ground floor area: 1,700 square feet.  
Total area: 1,700 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 10 feet.

Group 44 and 45.  
Building No. 5.  
Occupancy: Storage.  
Building type: Wood-frame (D).  
Fire classification: C.  
Ground zero: 7,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile roofing on wood sheathing.	0	100	Blast	
Trusses: Wood.	35	0	do	
First floor: Concrete on earth.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Wood siding on wood frame.	35	0	Blast	
Contents: Freight.	0	0		

Remarks: Structural damage to north section of this building; superficial damage to all of roofing.

# DAMAGE ANALYSIS

Dimensions: 68 by 140 feet.  
Ground floor area: 9,520 square feet.  
Total area: 9,520 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 10 feet.

Group 44 and 45.  
Building No. 6.  
Occupancy: Engine repair shop.  
Building type: Steel-frame (D).  
Fire classification: N.  
Ground zero: 7,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	100	Blast	
Trusses: Light steel.	0	0		
Columns: Lattice built up box type exterior walls.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	100	Blast	
Contents: Light machine tools.	0	0		

Remarks: No structural damage. Superficial damage to roof only.

# 18. Ice Plant—Group 49

This group of buildings was originally reported to have housed a small engine works, but it was found by ground survey to contain ice-making machinery. It consisted of 3 buildings with 14-inch brick walls, light timber truss roofs, and concrete floors, located on the western side of the bay, 8,800 feet from GZ. It was completely demolished by blast from the atomic bomb. There was no evidence of fire in the wreckage of these buildings, the outlines of which were so obscure that no lay-out plan could be made. Photos 224 and 225 show remains of the structures.

# 19. Mitsubishi Electric Manufacturing Company—Group 50

a. This group consisted of 11 buildings used by Mitsubishi Electric Co., and is shown on lay-out plan, Figure 35. The total plan area covered by the buildings was approximately 193,000 square feet. Building 1 was a steel-frame structure, all the others were of timber construction.

b. The only structural damage at the plant was in Buildings 2 and 9. All other buildings suffered

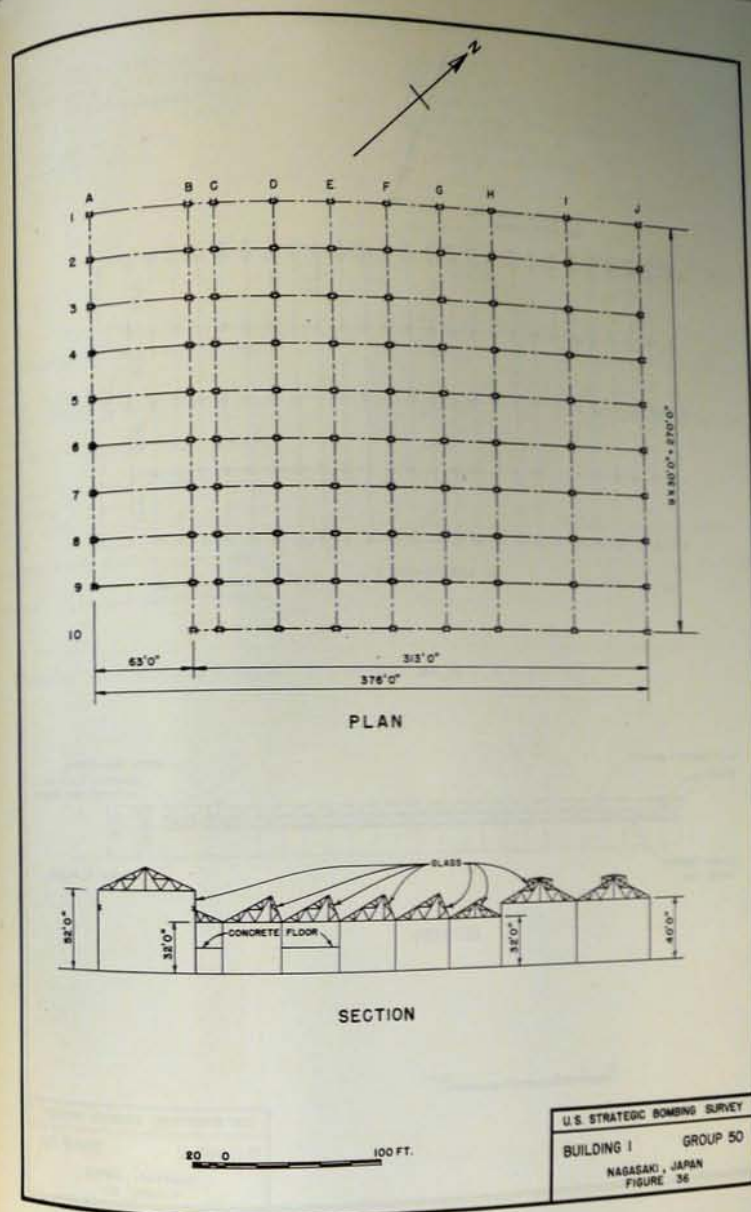
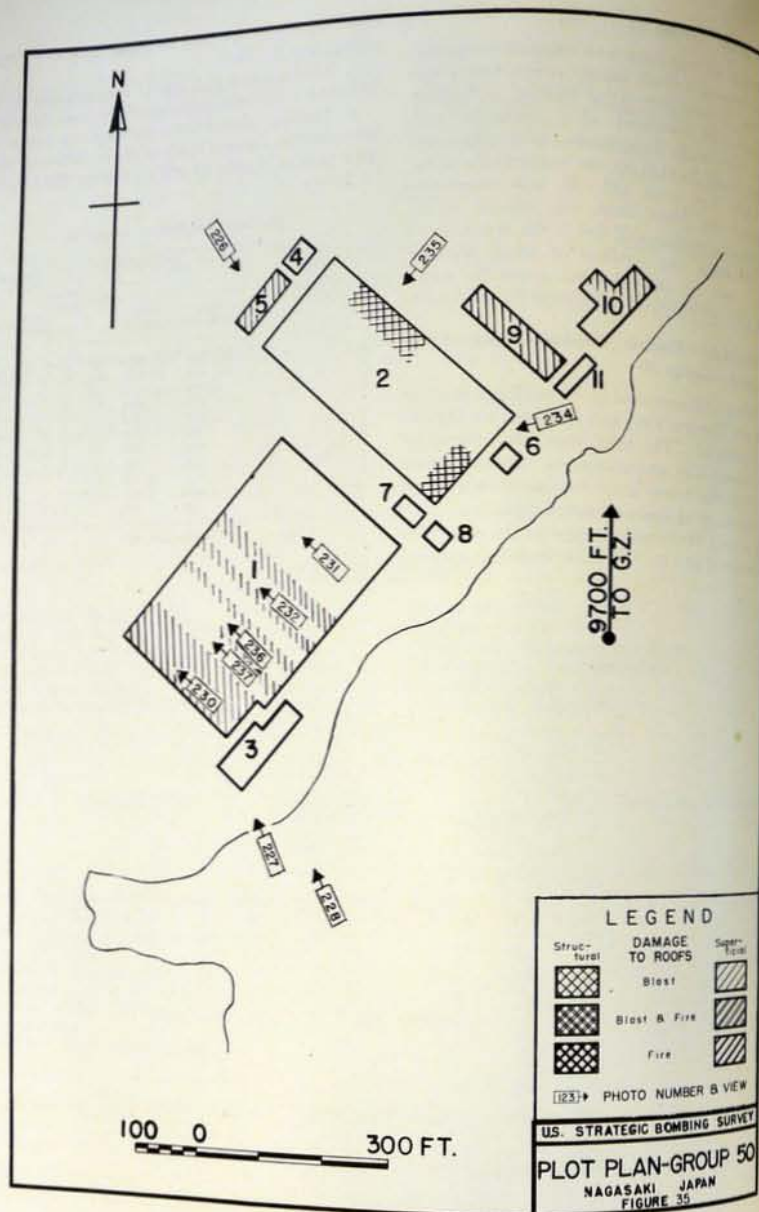
only superficial damage to glass, roof covering, siding, and the like.

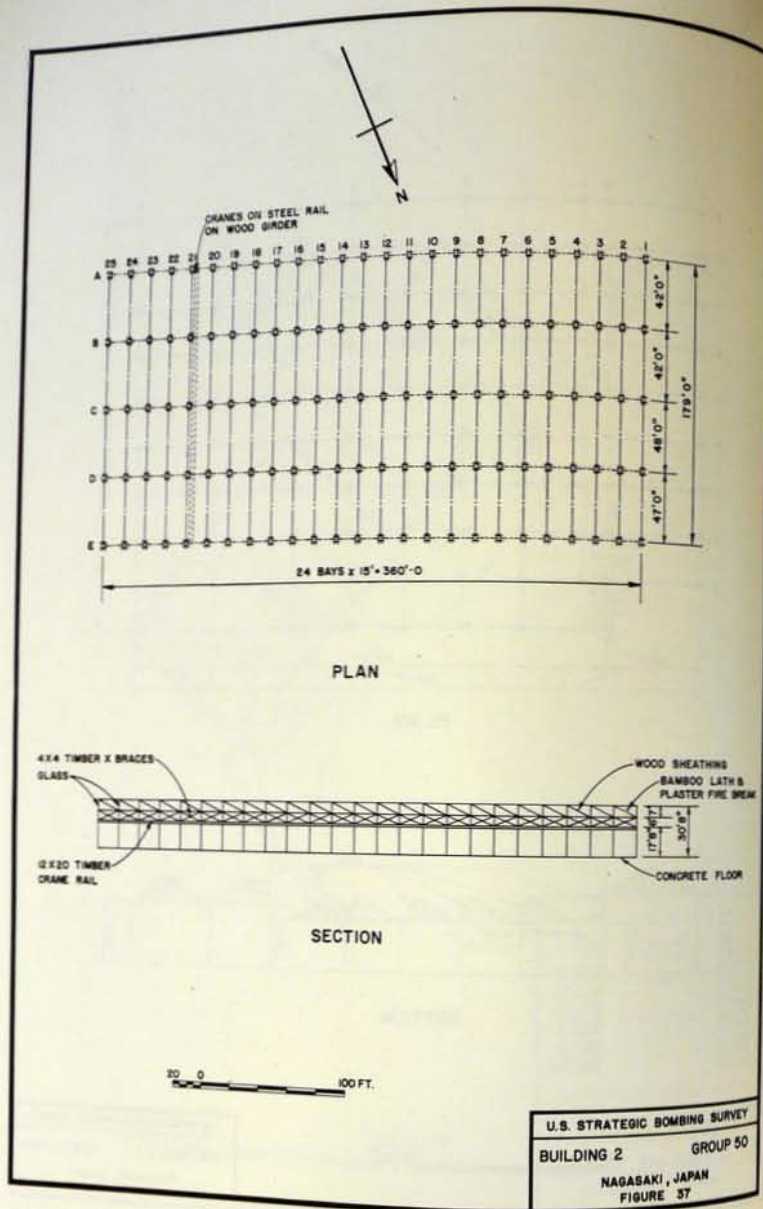
c. Buildings 4, 6, 7, 8, and 11 were not damaged. Building 5 received only superficial roof damage.

d. Further information regarding this group is given on the damage analysis sheets following the plot plan on Figure 35 and on Photos 225 to 237, inclusive.

# Building classification—Group 50

Building No.	Area		Type	Fire Class	Construction	
	Plan square feet	Total square feet			Steel frame	Wood
1.	102,600	102,600	E2	N	X	
2.	65,440	65,440	E1	N		X
3.	9,709	18,418	E2	C		X
4.	1,440	1,440	D	C		X
5.	3,880	7,760	E2	C		X
6.	300	300	D	C		X
7.	400	400	D	C		X
8.	300	300	D	C		X
9.	4,554	9,108	E2	C		X
10.	4,066	8,132	E2	C		X
11.	120	120	D	C		X
Total	192,809	214,018			1	10





## DAMAGE ANALYSIS

Dimensions: 270 by 376 feet.  
Ground floor area: 102,600 square feet.  
Total area: 102,600 square feet.  
Number of floors: 1.  
Bay height: 32 to 52 feet.  
Mean elevation: 10 feet.

Group 50.  
Building No. 1.  
Occupancy: Machine shops.  
Building type: Steel frame (E2).  
Fire classification: N.  
Ground zero: 9,700 feet.

Construction	Damage			Description of damage
	Struc- tural (per- cent)	Super- ficial (per- cent)	Cause	
Roof: Corrugated iron on steel pur- lins.	0	10	Blast	Roofing blasted from purlins.
Trusses: Light steel.	0	0		Photo 230.
Columns: Built-up lattice type, box steel.	0	0		Photos 231, 232, 236, and 237.
Second floor: Concrete slab in 2 bays only.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron.	0	10	Blast	Siding loosened from steel frame.
Windows: Clear glass in steel frame.	0	0		All window and roof lights broken.
Contents: Light and heavy machine tools.	0	0		

Remarks: No structural damage. Photos 230, 231, 232, 236, and 237.

# DAMAGE ANALYSIS

Dimensions: 179 by 360 feet.  
Ground floor area: 65,440 square feet.  
Total area: 65,440 square feet.  
Number of floors: 1.  
Eave height: 22 feet.  
Mean elevation: 10 feet.

Group 50.  
Building No. 2.  
Occupancy: Electric motor assembly.  
Building type: Wood frame (E1).  
Fire classification: C.  
Ground zero: 9,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tar paper on wood sheathing	20	0	Blast	Photos 229 and 234.
Trusses: Heavy timber	20	0	do	
Columns: Built-up timber	20	0	do	
First floor: Concrete on earth				
Foundation: Concrete piers				
Exterior walls: Wood frame and siding	20	0	Blast	Photos 233 and 235.
Windows: Clear glass, wood frames	100	0	do	All window and roof light broken.
Contents: Assembly machinery				

Remarks: Structural damage to roof members and columns caused by atomic bomb. No fire. Photos 229, 233, 234, and 235.

# DAMAGE ANALYSIS

Dimensions: Irregular shaped.  
Ground floor area: 9,709 square feet.  
Total area: 19,418 square feet.  
Number of floors: 2.  
Eave height: 25 feet.  
Mean elevation: 10 feet.

Group 50.  
Building No. 3.  
Occupancy: Office and stores.  
Building type: Wood frame (E2).  
Fire classification: C.  
Ground zero: 9,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tar paper on wood sheathing	0	0		All windows broken.
Trusses: Light timber	0	0		
Second floor: Wood flooring, wood joist	0	0		
First floor: Wood flooring, wood joist	0	0		
Foundation: 8-inch concrete walls	0	0		
Exterior walls: Wood siding, wood frame	0	0		
Interior walls: Wood lath and plaster	0	0		
Windows: Clear glass, wood frames	0	100	Blast	
Finish: Plaster	0	0		
Contents: Shelving and furniture	0	0		

Remarks: No structural damage.

# DAMAGE ANALYSIS

Dimensions: 33 by 138 feet.  
Ground floor area: 4,554 square feet.  
Total area: 9,108 square feet.  
Number of floors: 2.  
Eave height: 24 feet.  
Mean elevation: 10 feet.

Group 50.  
Building No. 9.  
Occupancy: Training shop.  
Building type: Wood frame (E2).  
Fire classification: C.  
Ground zero: 9,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile roof on wood sheathing	0	100	Blast	All tile loosened.
Trusses: Light timber	0	0		
Second floor: Wooden flooring on heavy wood joist	0	0		
First floor: Wooden flooring on heavy wood joist	0	0		
Foundation: Concrete walls	0	0		
Exterior walls: Wood siding on wood frame	25	0	Blast	Northeast end: Destroyed wooden reinforcing buttress.
Interior walls: Wood lath and plaster	0	10	do	Plaster fallen.
Windows: Clear glass	0	100	do	All glass broken.
Finish: Plaster	0	50	do	Plaster cracked and fallen.
Contents: Furniture	0	0		

Remarks: All damage from blast of atomic bomb. No fire. Photos 226 and 227.

# DAMAGE ANALYSIS

Dimensions: Irregular shaped.  
Ground floor area: 4,066 square feet.  
Total area: 8,132 square feet.  
Number of floors: 2.  
Eave height: 26 feet.  
Mean elevation: 10 feet.

Group 50.  
Building No. 10.  
Occupancy: Industrial School.  
Building type: Wood frame (E2).  
Fire classification: C.  
Ground zero: 9,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile roofing on wood sheathing	0	50	Blast	Approximately half tile loosened.
Trusses: Light wood	0	0		
Second floor: Wood floor on wood joist	0	0		
First floor: Wood floor on wood joist	0	0		
Foundation: Concrete walls	0	20	Blast	Stucco cracked.
Exterior walls: Stucco on wood lath and frame	0	20	do.	
Interior walls: Wood lath and plaster	0	100	do.	
Windows: Clear glass, wood frames	0	50	do.	
Finish: Plaster	0	0		Approximately 50 percent of all plaster cracked.
Contents: Furniture	0	0		

Remarks: No structural damage.

## 20. Takenokubo Substation—Group 51.

This was a single building located 3,600 feet south of GZ (Photos 238, 239). It was of unusually heavy concrete-and-steel construction and with-

stood the blast well. The north wall between the second floor and the roof was blown inward by the force of the blast, (Photos 239 and 241). Between the first and second floors, the north wall was fractured in several places (Photos 239 and 241).

# DAMAGE ANALYSIS

Dimensions: 66 by 36 feet.  
Ground floor area: 2,400 square feet.  
Total area: 3,800 square feet.  
Number of floors: 2.  
Eave height: 40 feet.  
Mean elevation: 10 feet.

Group 51.  
Building No. 1.  
Occupancy: Substation and switch house.  
Building type: Reinforced concrete and steel (E1).  
Fire classification: N.  
Ground zero: 3,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete slab on reinforced concrete beams and girders	0	0		Photo 242.
Trusses: Steel—under second floor only	0	0		
Columns: Reinforced concrete	0	0		
Second floor: Reinforced concrete slab on reinforced concrete beams and girders. Also reinforced concrete slab on steel trusses.	0	0		
First floor: Reinforced concrete				North wall above second floor blasted in. Photos 239 and 241.
Foundation: Reinforced concrete	30	0	Blast	
Exterior walls: 8-inch reinforced concrete.				
Interior walls: Lath and plaster	20	0	do.	
Windows: Steel sash	0	100	do.	All glass gone.
Contents: Control equipment and switchboards.				

Remarks: Photos 238 to 243, inclusive.

# 21. Akunoura Engine Works—Group 52.

a. There were 24 buildings in this group which housed a heavy marine engine works and some main offices of the Mitsubishi Shipbuilding Co., the major manufacturing concern in the city. The group occupied an irregular area following the shore line on the west side of the bay and extending from 9,800 to 12,500 feet southwest of

GZ. The buildings covered a total plan area of approximately 861,710 square feet and contained a total floor area of approximately 1,331,770 square feet. They were of many different types of construction; frequently several types of construction were found in a single building, necessitating division of the buildings as listed in the table which follows:

Building classification—Group 52

Building No.	Area		Type	Fire class	Construction			
	Plan (square feet)	Total (square feet)			Steel frame	Reinforced concrete	Load-bearing wall	Wood
1a1	1,820	1,820	D	N				
1a2	1,040	1,040	D	N	X		X	
1b1	2,810	2,810	D	C				
1b2	1,680	1,680	D	C				
1b3	3,890	3,890	D	C				
1b4	3,900	3,900	D	N	X			
1e1	2,900	2,900	D	N	X			
1e2	8,100	8,100	D	N				
2a1	2,000	4,000	F2	C				
2a2	3,800	7,600	E2	C	X			
2c1	6,700	6,700	D	C				
2a4	4,960	9,920	E2	C				
2a3	2,500	2,500	D	C				
2c2	7,300	14,600	E2	N&R		X		
3	1,700	1,700	D	N				
4a	6,400	12,800	E2	N				
4b	6,000	18,000	E2	N				
4c	19,200	19,200	C2.2	N	X			
5a	4,800	4,800	D	C				
5b2	10,900	21,800	E2	C				
6a	1,400	2,800	E2	C				
7	5,900	11,800	E2	C				
8a	9,200	9,200	D	N	X			
8b	10,800	10,800	A2.3	N	X			
8c	4,000	8,000	E2	N&R		X		
9a	3,100	6,200	E2	N	X			
9b	6,100	6,100	D	N	X			
10a1	3,200	3,200	D	N	X			
10a2	3,200	3,200	D	C				
10b1	11,800	23,600	F2	C				
10b2	5,600	5,600	D	N				
11	4,200	4,200	D	N	X			
12a1	42,200	59,900	B2	N	X			
12a2								
12a3								
12a4								
12a5								
12a6								
12b	21,000	21,000	C2.2	N	X			
12c1	6,800	6,800	D	N	X			
12c2								
12c3	9,600	9,600	D	N	X			
12c4								
12c5	14,600	14,600	A2.3	N	X			
12c6	10,200	10,200	A2.3	N	X			
12d1	41,600	83,200	E2	N	X			
12d2								
12d3								
12e1	51,500	51,500	A2.3	N	X			
12e2	46,900	46,900	B1	N	X			

Building classification—Group 52—Continued

Building No.	Area		Type	Fire class	Construction			
	Plan (square feet)	Total (square feet)			Steel frame	Reinforced concrete	Load-bearing wall	Wood
12e3	9,000	9,000	D	N	X			
12e4								
12e5	57,500	57,500	B1	N	X			
12e6	36,500	51,200	B1	N	X			
12e7	7,800	23,400	E2	N	X			
12e8	3,700	3,700	D	N	X			
12e9	10,100	20,200	E2	N	X			
12f1								
12f2	7,300	21,900	E1	R				
12f3								
12f4	92,500	92,500	B1	N	X			
12f5								
12f6	17,200	34,400	E2	N	X			
12f7	22,400	22,400	B2	N	X			
12f8	1,700	3,400	E1	N	X			
12f9	4,700	4,700	D	N	X			
12g1	8,300	16,600	E2	C&N	X			
12g2	12,800	38,400	E2	C&N	X			
12g3	12,600	25,200	E2	R				
12g4	8,600	17,200	E2	C&R				
12g5	2,600	5,200	F2	C&N				
12g6	7,600	7,600	D	C&N				
12g7	32,400	98,200	E1	R				
12g8								
12g9	12,300	73,800	E1	R				
12h1	3,800	7,600	E1	R				
12h2	800	800	D	C&N				
12h3								
12h4	12,200	36,600	E1	R				
12h5	8,200	16,400	E1	R				
12h6	7,700	23,100	E1	R				
12h7	5,900	11,800	E2	C				
Total	861,710	1,331,770						

1 Hammerhead crane.

\* These figures include subdivisions of major buildings.

4. Group 52 was the subject of a photo-intelligence study which is included in part 1 of this report. Additional information and a detailed plot plan of the group will be found in this part.

c. Most of the damage in this plant was caused by high-explosive bombs in an attack made on 1 August 1945, 8 days prior to the atomic-bomb attack.

d. For purposes of study the group has been divided into 68 sections according to type of construction. Thirty-four of these, comprising by far the largest part of the group, were of steel-frame construction. Of these, only two sections, 1e2, a section of the boiler room at the power plant, and 12c6, part of the foundry, suffered structural damage from the atomic bomb. Superficial damage from the atomic bomb's blast was sustained by Buildings 5, 8, 9, and 16. The

high-explosive attack caused structural or superficial damage in 4 steel-frame buildings (Nos. 11, 12, 15, and 16). Only Building 11 was totally damaged.

e. Building 12, an extremely large building of steel-frame construction, housed the foundry and machine, shipfitters, and erecting shops. Some sections of it were multistory, while in other sections additional floor space had been made available by putting up temporary additional stories of wood; these were not considered as multistory structures although the additional floor space was taken into account in the tabulation of areas. The building was struck by a number of high-explosive bombs, most of which fell in the foundry, causing a large amount of structural and superficial damage. Some roof stripping was caused by the atomic bomb which also bent the

f. Building 15, the boiler shop, suffered heavy structural and superficial damage from high-explosive bombs. Damage to machine tools within the building was also heavy. The atomic bomb caused very little additional damage.

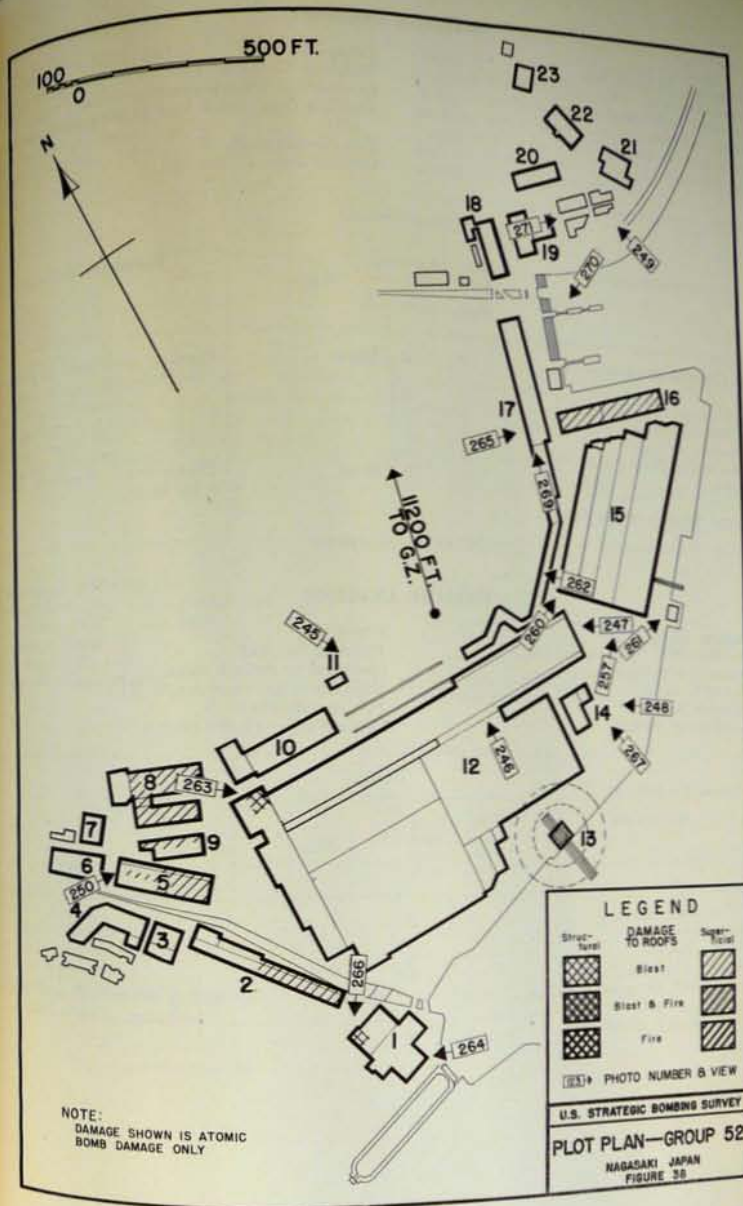
g. A steel-frame storage building (No. 16) suffered some structural damage from a high-explosive near miss. All its roofing was blown off by the atomic bomb which also caused minor damage to windows and corrugated metal siding on the exposed north side of the building.

h. There were 11 reinforced-concrete buildings or sections of buildings as summarized in the building classification table (Buildings 3, 8c, 14, 17a1, 17a2, 17d, 18a, and b, 18B, 19a and b, 20, and 22). None of these was structurally damaged by the atomic bomb, although Buildings 18, 19a, 19b, 20, and 22 sustained minor damage.

f. There were 15 examples of load-bearing wall construction in the group, none of which suffered more than superficial damage from the atomic bomb. With the exception of all of Building 4 and Section b1 of Building 10, all had timber roof trusses. Hits and near misses by high explosives and fire which resulted therefrom severely damaged Sections b and c of Building 17.

j. Seven buildings or sections of buildings of wood-frame construction. None of these damaged.

k. Damage to buildings in this group and details of construction are shown in Photos 244 to 250 and listed in the damage analysis sheets. Figure 38 shows damage caused by the atomic bomb on



# DAMAGE ANALYSIS

Dimensions: 52 by 35 feet.  
Ground floor area: 1,820 square feet.  
Total area: 1,820 square feet.  
Number of floors: 1.  
Eave height: 24 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1a1.  
Occupancy: Switch room.  
Building type: Brick load-bearing wall, steel trusses (D).  
Fire classification: N.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	5	Blast	Roofing shattered at east end of building.
Trusses: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Windows	0	20	Blast	Photo 264. Windows broken by blast.
Contents: Electric switch gear	0	0		

# DAMAGE ANALYSIS

Dimensions: 52 by 20 feet.  
Ground floor area: 1,040 square feet.  
Total area: 1,040 square feet.  
Number of floors: 1.  
Eave height: 24 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1a2.  
Occupancy: Switch room.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		Siding blown off east end of building. Photo 264.
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated asbestos	0	50	Blast	
Contents: Electric switch gear	0	0		

# DAMAGE ANALYSIS

Dimensions: 76 by 37 feet.  
Ground floor area: 2,810 square feet.  
Total area: 2,810 square feet.  
Number of floors: 1.  
Eave height: 32 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1b1.  
Occupancy: Switchboard room.  
Building type: Brick load-bearing wall, wooden trusses (D).  
Fire classification: C.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Contents: Switchboard	0	0		

# DAMAGE ANALYSIS

Dimensions: 48 by 35 feet.  
Ground floor area: 1,680 square feet.  
Total area: 1,680 square feet.  
Number of floors: 1.  
Eave height: 32 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1b2.  
Occupancy: Turbine room.  
Building type: Brick load-bearing walls, wood trusses (D).  
Fire classification: C.  
Ground zero: 12,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Contents: Turbines and generators	0	0		

# DAMAGE ANALYSIS

Dimensions: 102 by 38 feet.  
Ground floor area: 3,800 square feet.  
Total area: 3,800 square feet.  
Number of floors: 1.  
Eave height: 24 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1b3.  
Occupancy: Switch board room.  
Building type: Brick load-bearing walls, wood truss (D).  
Fire classification: C.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	0		
Trusses: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Contents: Switchboard	0	0		

# DAMAGE ANALYSIS

Dimensions: 113 by 35 feet.  
Ground floor area: 3,900 square feet.  
Total area: 3,900 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1b4.  
Occupancy: Turbine room.  
Building type: Brick load-bearing walls, wood truss (D).  
Fire classification: C.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	0		
Trusses: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Contents: Turbines and generators	0	0		

# DAMAGE ANALYSIS

Dimensions: 55 by 52 feet.  
Ground floor area: 2,900 square feet.  
Total area: 2,900 square feet.  
Number of floors: 1.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1c1.  
Occupancy: Boiler room.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated iron	0	0		
Contents: Boilers	0	0		

# DAMAGE ANALYSIS

Dimensions: 77 by 73 feet over-all.  
Ground floor area: 8,100 square feet.  
Total area: 8,100 square feet.  
Number of floors: 1.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 1c2.  
Occupancy: Boiler room (D).  
Building type: Steel frame (brick wall on north side).  
Fire classification: N.  
Ground zero: 12,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated iron except 9-inch brick wall up to 13 feet on north side.	18	0	Blast	Blast caused brick wall to collapse. Photo 266.
Contents: Boilers	0	0		

# DAMAGE ANALYSIS

Dimensions: 67 by 31 feet.  
Ground floor area: 2,000 square feet.  
Total area: 4,000 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 2a1.  
Occupancy: Storage.  
Building type: Brick load-bearing walls, wood truss (F-2).  
Fire classification: C.  
Ground zero: 12,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		

# DAMAGE ANALYSIS

Dimensions: 62 by 31 feet; 62 by 31 feet.  
Ground floor area: 3,800 square feet.  
Total area: 7,600 square feet.  
Number of floors: 2.  
Eave height: 35 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 2a2; 2c1.  
Occupancy: Welding shop.  
Building type: Steel frame, wood truss, brick wall (E2).  
Fire classification: C.  
Ground zero: 12,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
Columns: Steel	0	0		
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Wood, second floor; brick, first floor.	0	0		
Contents: Acetylene generators and welding apparatus.	0	0		

# DAMAGE ANALYSIS

Dimensions: 218 by 31 feet.  
Ground floor area: 6,700 square feet.  
Total area: 6,700 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 2a4.  
Occupancy: Coppersmith's shop.  
Building type: Steel columns, wood truss, brick and wood wall panels (D).  
Fire classification: C.  
Ground zero: 12,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	100	Atomic blast	Widespread disturbance of roof tile required relaying or replacement.
Trusses: Wood	0	0		
Columns: Steel	0	0		
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick to 20 feet, wood above.	0	0		

# DAMAGE ANALYSIS

Dimensions: 80 by 31 feet, 80 by 31 feet.  
Ground floor area: 4,960 square feet.  
Total area: 9,920 square feet.  
Number of floors: 2.  
Eave height: 35 feet.  
Mean elevation: 15 feet.

Group 52.  
Building Nos. 2a3, 2c2.  
Occupancy: Welding shop.  
Building type: Steel-frame, wood truss, wood walls (E2).  
Fire classification: C.  
Ground zero: 12,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
Columns: Steel	0	0		
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Wood	0	0		
Contents: Acetylene generators and welding apparatus.	0	0		

# DAMAGE ANALYSIS

Dimensions: 67 by 38 feet.  
Ground floor area: 2,500 square feet.  
Total area: 2,500 square feet.  
Number of floors: 1.  
Eave height: 30 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 2d.  
Occupancy: Storage.  
Building type: Brick load-bearing walls, wood trusses (D).  
Fire classification: C.  
Ground zero: 12,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
Columns: Wood (along center line)	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		

# DAMAGE ANALYSIS

Dimensions: 135 by 54 feet.  
Ground floor area: 7,300 square feet.  
Total area: 14,600 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 3.  
Occupancy: Hospital.  
Building type: Reinforced concrete walls, steel truss (E2).  
Fire classification: N.  
Ground zero: 11,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Steel	0	0		
Second floor: Concrete	0	0		
First floor: Concrete and tile	0	0		
Foundation: Concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Interior walls: Plaster on wood lath	0	0		
Windows	0	50	Blast	Glass and a few frames blown in on side toward zero.
Finish	0	10	do	Most of plaster blown off ceilings on side toward zero.
Contents: Hospital furniture	0	0		

# DAMAGE ANALYSIS

Dimensions: 42 by 41 feet.  
Ground floor area: 1,700 square feet.  
Total area: 1,700 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 4a.  
Occupancy: Operating room.  
Building type: Brick load-bearing walls, steel truss (D).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile	0	0		
Trusses: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Contents: Operating table	0	0		

# DAMAGE ANALYSIS

Dimensions: 63 by 54 feet; 54 by 42 feet; 35 by 21 feet.  
Ground floor area: 6,400 square feet.  
Total area: 12,800 square feet.  
Number of floors: 2.  
Eave height: 32 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 4b, c, d.  
Occupancy: Hospital.  
Building type: Brick load-bearing walls, steel truss (E2).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Composition shingles	0	0		
Trusses: Steel	0	0		
Second floor: Concrete	0	0		
First floor: Concrete and tile	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Interior walls: Brick	0	0		
Windows	0	30	Blast	Windows and some frames blown out on east side.
Contents: Hospital furniture	0	0		

# DAMAGE ANALYSIS

Dimensions: 111 by 54 feet.  
Ground floor area: 6,000 square feet.  
Total area: 18,000 square feet.  
Number of floors: 3.  
Eave height: 44 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 4c.  
Occupancy: Hospital.  
Building type: Brick load-bearing walls, truss (E2).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Composition shingles	0	0		
Trusses: Steel	0	0		
Third floor: Concrete	0	0		
Second floor: Concrete	0	0		
First floor: Concrete and tile	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Interior walls: Brick	0	30	Blast	Glass and some frames on east side.
Windows	0	0		
Contents: Hospital furniture	0	0		

# DAMAGE ANALYSIS

Dimensions: 240 by 80 feet.  
Ground floor area: 19,200 square feet.  
Total area: 19,200 square feet.  
Number of floors: 1.  
Eave height: 37 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 5a.  
Occupancy: Storage.  
Building type: Steel-frame (C2.2).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	60	Blast	
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Reinforced concrete, corrugated metal above.	0	25	Blast	Blast bowed members supporting sheeting on walls north and south ends of building.
Windows	0	100	do	
Contents: Steel bars and rods on wood racks.	0	0		

# DAMAGE ANALYSIS

Dimensions: 5b1, 160 by 20 feet; 5b2, 80 by 20 feet.  
Ground floor area: 4,800 square feet.  
Total area: 4,800 square feet.  
Number of floors: 1.  
Eave height: 5b1, 15 feet; 5b2, 20 feet.  
Mean elevation: 15 feet.

Group 52.  
Building Nos. 5b1, 5b2.  
Occupancy: Storage.  
Building type: Wood-frame sheds (D).  
Fire classification: C.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Wood	0	0		
Columns: Wood	0	0		
First floor: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Steel bars and rods on wood racks.	0	0		

# DAMAGE ANALYSIS

Dimensions: 154 by 71 feet.  
Ground floor area: 10,900 square feet.  
Total area: 21,800 square feet.  
Number of floors: 2.  
Eave height: 20 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 6.  
Occupancy: Storage.  
Building type: Wood frame; gable and saw-tooth roofs (E2).  
Fire classification: C.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 50 percent corrugated metal; 50 percent tiles.	0	0		
Trusses: Wood	0	0		
Columns: Wood	0	0		
Second floor: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Plaster on wood lath.	0	0		
Interior walls: Wood	0	0		
Contents: Miscellaneous	0	0		

# DAMAGE ANALYSIS

Dimensions: 40 by 35 feet.  
Ground floor area: 1,400 square feet.  
Total area: 2,800 square feet.  
Number of floors: 2.  
Eave height: 20 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 6A.  
Occupancy: Storage.  
Building type: Wood frame, gable roof (E2).  
Fire classification: C.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
Columns: Wood	0	0		
Second floor: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Plaster on wood lath	0	0		
Contents: Steel rods and bars on wood racks	0	0		

# DAMAGE ANALYSIS

Dimensions: 85 by 69 feet.  
Ground floor area: 5,900 square feet.  
Total area: 11,800 square feet.  
Number of floors: 2.  
Eave height: 20 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 7.  
Occupancy: Storage.  
Building type: Wood frame, gable and sawtooth roofs (E2).  
Fire classification: C.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
Columns: Wood	0	0		
Second floor: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Plaster on wood lath	0	0		
Contents: Steel bars and rods on wood racks	0	0		

# DAMAGE ANALYSIS

Dimensions: 150 by 61 feet.  
Ground floor area: 9,200 square feet.  
Total area: 9,200 square feet.  
Number of floors: 1.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 8a.  
Occupancy: Foundry (tool shop).  
Building type: Steel frame, gable roofs (D).  
Fire classification: N.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Blast shattered asbestos, usually breaking wooden purlins.
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	40	Blast	Blast stripped part of walls on east side.
Windows	0	100	do	Windows and frames both blown out.
Contents: Forges and small furnaces	0	0		

# DAMAGE ANALYSIS

Dimensions: 150 by 72 feet.  
Ground floor area: 10,800 square feet.  
Total area: 10,800 square feet.  
Number of floors: 1.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 8b.  
Occupancy: Brass foundry.  
Building type: Steel frame, gable roofs (A2.3).  
Fire classification: N.  
Ground zero: 11,400 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Roof completely stripped, purlins broken. Photo 251.
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	50	Blast	Large areas of sheeting blown off both sides of building.
Windows	0	100	do	Glass and almost all frames blown out.
Contents: Furnaces, small forges, and small machine tools	0	0		

# DAMAGE ANALYSIS

Dimensions: 108 by 30 feet.  
Ground floor area: 3,200 square feet.  
Total area: 3,200 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 10a1.  
Occupancy: Pattern storage.  
Building type: Steel frame, gable roof (D).  
Fire classification: N.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	10	Blast	
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Wood patterns	0	0		

# DAMAGE ANALYSIS

Dimensions: 80 by 50 feet.  
Ground floor area: 4,000 square feet.  
Total area: 8,000 square feet.  
Number of floors: 2.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 8c.  
Occupancy: First floor—machine shop; second floor—offices.  
Building type: Reinforced concrete (E2).  
Fire classification: N and R.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Concrete covered with bitu-minous material.	0	0		
Second floor: Concrete supported on steel beams.	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete	0	0		
Contents: First floor small machine tools; second floor office furniture.	0	0		

# DAMAGE ANALYSIS

Dimensions: 125 by 25 feet.  
Ground floor area: 3,100 square feet.  
Total area: 6,200 square feet.  
Number of floors: 2.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 9a.  
Occupancy: Forge shop.  
Building type: Steel frame, gable roof (E2).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	75	Blast	Roof stripping on east side of roof.
Trusses: Steel	0	0		
Columns: Steel	0	0		
Second floor: Concrete on steel beams.	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Windows	0	40	Blast	Broken glass only.

# DAMAGE ANALYSIS

Dimensions: 175 by 35 feet.  
Ground floor area: 6,100 square feet.  
Total area: 6,100 square feet.  
Number of floors: 1.  
Eave height: 31 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 9b.  
Occupancy: Forge shop.  
Building type: Steel frame, gable roof (D).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	100	Blast	Entire roof stripped.
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated steel	0	10	Blast	Some sheeting stripped on east side.
Windows	0	30	do.	Glass broken in windows on east side.
Contents: Heavy forges	0	0		

# DAMAGE ANALYSIS

Dimensions: 108 by 30 feet.  
Ground floor area: 3,200 square feet.  
Total area: 3,200 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 10a2.  
Occupancy: Pattern storage.  
Building type: Wood frame, gable roof (D).  
Fire classification: C.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	75	Blast	
Trusses: Wood	0	0		
Columns: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Contents: Wood patterns	0	0		

# DAMAGE ANALYSIS

Dimensions: 168 by 70 feet.  
Ground floor area: 11,800 square feet.  
Total area: 23,600 square feet.  
Number of floors: 2.  
Eave height: 29 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 10b.  
Occupancy: Pattern shop.  
Building type: Brick load-bearing walls, wood truss (F2).  
Fire classification: C.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Tile	0	0		
Trusses: Wood	0	0		
Columns: Brick (25 by 30 inches)	0	0		
Second floor: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick (14 inch)	0	0		
Contents: Woodworking machinery	0	0		

# DAMAGE ANALYSIS

Dimensions: 80 by 70 feet.  
Ground floor area: 5,600 square feet.  
Total area: 5,600 square feet.  
Number of floors: 1.  
Eave height: 29 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 10b2.  
Occupancy: Pattern shop.  
Building type: Brick load-bearing walls, steel truss (D).  
Fire classification: N.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Tile	0	100	Blast	Disturbance of tiles required relaying or replacement.
Trusses: Steel	0	0		
Columns: Brick (25 by 30 inches)	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick (14 inches)	0	0		
Contents: Woodworking machinery	0	0		

# DAMAGE ANALYSIS

Dimensions: 70 by 60 feet (from photos).  
Ground floor area: 4,200 square feet.  
Total area: 4,200 square feet.  
Number of floors: 1.  
Eave height: Not known.  
Mean elevation: 15 feet.

Group 52.  
Building No. 11.  
Occupancy: Coke storage.  
Building type: Steel frame (D).  
Fire classification: N.  
Ground zero: 11,200 feet.

Completely destroyed by HE bombs. Site cleared before survey.

# DAMAGE ANALYSIS

Dimensions: a1, 295 by 30 feet; a2, 295 by 56 feet; and a3, 295 by 57 feet.  
Ground floor area: 42,200 square feet.  
Total area: 59,900 square feet.  
Number of floors: a1, 3; a2, 1; and a3, 1.  
Eave height: 47 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12a1, a2, and a3.  
Occupancy: Erecting shop, light cranes.  
Building type: Steel-frame (B2).  
Fire classification: N.  
Ground zero: 11,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
Third floor (a1 only): Concrete	0	0		
Second floor (a1 only): Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Equipment for assembly of engines	0	0		

# DAMAGE ANALYSIS

Dimensions: a4, 295 by 35 feet; a5, 295 by 51 feet; and a6, 295 by 51 feet.  
Ground floor area: 40,300 square feet.  
Total area: 60,900 square feet.  
Number of floors: a4, 3; a5, 1; and a6, 1.  
Eave height: a4, 59 feet, and a5 and a6, 53 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12a4, a5, and a6.  
Occupancy: Machine shop.  
Building type: Steel-framed; light cranes (B).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
Third floor (a4 only): Concrete	0	0		
Second floor (a4 only): Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Heavy machine tools	0	0		

# DAMAGE ANALYSIS

Dimensions: 284 by 79 feet.  
Ground floor area: 21,600 square feet.  
Total area: 21,600 square feet.  
Number of floors: 1.  
Eave height: 27 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12b.  
Occupancy: Shipfitters' shop (welding).  
Building type: Steel-frame; no cranes (C22).  
Fire classification: N.  
Ground zero: 11,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel protected with concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete	0	0		
Contents: Welding apparatus	0	0		

# DAMAGE ANALYSIS

Dimensions: 90 by 76 feet.  
Ground floor area: 6,800 square feet.  
Total area: 6,800 square feet.  
Number of floors: 1.  
Eave height: 27 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12c1.  
Occupancy: Coppersmiths' shop.  
Building type: Steel-frame (D).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Welding apparatus	0	0		

# DAMAGE ANALYSIS

Dimensions: c2, 127 by 17 feet; c4, 131 by 21 feet; and c5, 118 by 39 feet.  
Ground floor area: 9,600 square feet.  
Total area: 9,600 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12c2, c4, and c5.  
Occupancy: Coppersmiths' shop.  
Building type: Steel-frame (D).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Welding apparatus	0	0		

# DAMAGE ANALYSIS

Dimensions: 249 by 59 feet.  
Ground floor area: 14,600 square feet.  
Total area: 14,600 square feet.  
Number of floors: 1.  
Eave height: 27 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12c3.  
Occupancy: Coppersmiths' shop.  
Building type: Steel-frame (A2.3).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Welding apparatus	0	0		

# DAMAGE ANALYSIS

Dimensions: 114 by 90 feet.  
Ground floor area: 10,200 square feet.  
Total area: 10,200 square feet.  
Number of floors: 1.  
Eave height: 34 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12c6, c7.  
Occupancy: Brass foundry.  
Building type: Steel-frame; no cranes (A2.3).  
Fire classification: N.  
Ground zero: 11,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	60	0	Blast	4 of 7 trusses in building bent sufficiently to cause serious sag at north end of building. Only columns deflected were those supporting end wall. These did not support roof.
Columns: Steel	12	0		
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	20	0	Blast	Wall at north end supported by columns bent 6 feet out of vertical. Photo 263.
Windows	0	50	do	Windows blown out on north side of building.
Contents: Moulding equipment	0	0		

# DAMAGE ANALYSIS

Dimensions: d1, 359 by 35 feet; d2, 359 by 52 feet; and d3, 359 by 29 feet.  
Ground floor area: 41,600 square feet.  
Total area: 83,200 square feet.  
Number of floors: 2.  
Eave height: d1, 47 feet; d2, 44 feet; d3, 40 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12d1, d2, and d3.  
Occupancy: Machine shop.  
Building type: Steel-frame, multistory (E2).  
Fire classification: N.  
Ground zero: 11,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
Second floor: Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Heavy machine tools	0	0		

# DAMAGE ANALYSIS

Dimensions: e1, 918 by 25 feet; e3, 918 by 25 feet; and f, 370 by 25 feet.  
Ground floor area: 51,500 square feet.  
Total area: 51,500 square feet.  
Number of floors: 1.  
Eave height: e1, 22 feet; e3, 22 feet; f, 30 feet.  
Mean elevation: 15 feet.

Group 52.  
Building Nos. 12e1, e3, and f.  
Occupancy: Brass and iron foundry.  
Building type: Steel-frame; no cranes (A23).  
Fire classification: N.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	30	Blast	Most of damage due to high explosive bombs. Some additional damage by atomic bomb.
Trusses: Steel	25	0	Blast, fragments, debris.	All damage caused by high explosive bombs.
Columns: Steel	5	0	Blast and fragments.	All due to high explosive. Two columns almost destroyed, one badly bent, several slightly bent.
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	30	Blast	Large amount of siding stripped from north side of e3 and f.
Windows	0	40	do	Most of windows broken on north side of building.
Contents: Furnaces and moulding equipment				See 12e2.

Remarks: Figures for superficial roof damage do not include areas structurally damaged although these were also stripped of roofing.

# DAMAGE ANALYSIS

Dimensions: 918 by 51 feet.  
Ground floor area: 46,900 square feet.  
Total area: 46,900 square feet.  
Number of floors: 1.  
Eave height: 34 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12e2.  
Occupancy: Brass and iron foundry.  
Building type: Steel-frame; heavy crane (B1).  
Fire classification: N.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated asbestos	0	30	Blast	Almost all due to high explosives.
Trusses: Steel	30	0	Blast, fragments, debris.	Same damage as 12e1, e3, and f.
Columns: Steel	5	0	Blast and fragments.	Do.
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls (only one end wall): Corrugated metal	0	100	Blast	Completely destroyed.
Contents: Furnaces and moulding equipment	25	0	Fragments	One traveling crane and one cupola destroyed.

Remarks: Figures for superficial roof damage do not include areas structurally damaged although these were also stripped of roofing. Photos 245, 246, and 247.

# DAMAGE ANALYSIS

Dimensions: g1, 130 by 9 feet; g2, 102 by 18 feet; g3, 81 by 19 feet; and g4, 75 by 13 feet.  
Ground floor area: 9,000 square feet.  
Total area: 9,000 square feet.  
Number of floors: 1.  
Eave height: 15 feet.  
Mean elevation: 15 feet.

Group 52.  
Building Nos. 12g1, g2, g3, and g4.  
Occupancy: Foundry.  
Building type: Steel-frame (D).  
Fire classification: N.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated metal	0	100	Blast and fragments.	
Trusses: Steel	100	0	do	
Columns: Steel	100	0	do	
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	100	Blast and fragments.	
Contents: Unknown	0	100		

Remarks: These small buildings destroyed by high-explosive bombs and would require complete rebuilding.

# DAMAGE ANALYSIS

Dimensions: h1, 420 by 86 feet and h2, 420 by 51 feet.  
Ground floor area: 57,500 square feet.  
Total area: 57,500 square feet.  
Number of floors: 1.  
Eave height: h1, 71 feet and h2, 54 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12h1, and h2.  
Occupancy: Erecting shop.  
Building type: Steel-frame; heavy cranes (B).  
Fire classification: N.  
Ground zero: 11,400 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	60	Blast	Almost entirely due to high explosive. Two trusses so severely damaged as to require replacement. Most of damage was due to fragments.
Trusses: Steel	7	0	Blast and fragments.	
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	50		
Contents: Equipment for assembly of engines, also some machine tools.	0	0		

# DAMAGE ANALYSIS

Dimensions: h3, 420 by 35 feet and h4, 420 by 52 feet.  
Ground floor area: 36,500 square feet.  
Total area: 51,200 square feet.  
Number of floors: h3, 2 and h4, 1.  
Eave height: h3, 49 feet and h4, 65 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12h3 and h4.  
Occupancy: Machine shop.  
Building type: Steel-frame; heavy cranes (B).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	40	Blast	Two trusses bent by high explosive bomb. Will require replacement. Photo 246.
Trusses: Steel	7	0	do	
Columns: Steel				
Second floor (h3 only): Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	80	Blast	
Windows	0	100	do	
Contents: Heavy machine tools	0	0		

Remarks: Crane rail damaged along side area of damage in h5.

# DAMAGE ANALYSIS

Dimensions: 270 by 29 feet.  
Ground floor area: 7,800 square feet.  
Total area: 23,400 square feet.  
Number of floors: 3.  
Eave height: 65 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12h5.  
Occupancy: Machine shop.  
Building type: Steel-frame; multistory (E2).  
Fire classification: N.  
Ground zero: 11,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated asbestos	0	70	Blast	High-explosive bomb exploded just below third floor, blowing out portion of 2 floors as well as crane rail in h4. Photo 246.
Trusses: Steel	6	0	do	
Columns: Steel	0	0		
Third floor: Concrete	6	0	Blast and fragments.	
Second floor: Concrete	6	0	Blast, debris, and fragments.	
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	60	Blast and fragments.	
Contents: Machine tools	0	0		

Remarks: Falling debris did not damage any machines in this section. Photo 246.

# DAMAGE ANALYSIS

Dimensions: 74 by 50 feet.  
Ground floor area: 3,700 square feet.  
Total area: 3,700 square feet.  
Number of floors: 1.  
Eave height: 32 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 12j.  
Occupancy: Storage.  
Building type: Steel-frame (D).  
Fire classification: N.  
Ground zero: 11,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Unknown	0	0		

# DAMAGE ANALYSIS

Dimensions: m, 113 by 50 feet and k, 113 by 39 feet.  
 Ground floor area: 10,100 square feet.  
 Total area: 20,200 square feet.  
 Number of floors: 2.  
 Eave height: 52 feet.  
 Mean elevation: 15 feet.

Group 52.  
 Building No. 12k and m.  
 Occupancy: Offices.  
 Building type: Multistory, steel-frame (E2).  
 Fire classification: N.  
 Ground zero: 11,800 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
Second floor: Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Office furniture	0	0		

# DAMAGE ANALYSIS

Dimensions: 52 by 47 feet and 111 by 44 feet.  
 Ground floor area: 7,300 square feet.  
 Total area: 21,900 square feet.  
 Number of floors: 3.  
 Eave height: 45 feet.  
 Mean elevation: 15 feet.

Group 52.  
 Building No. 14.  
 Occupancy: Cafeteria and offices.  
 Building type: Multistory, reinforced-concrete frame (E1).  
 Fire Classification: R.  
 Ground zero: 11,600 feet.

Construction	Damage			Description of damage
	Structural (per-cent)	Superficial (per-cent)	Cause	
Roof: Concrete	73	0	Blast, fragments, and fire.	Sags at south end of building; collapsed in north wing.
Columns: Concrete (approximately 24-in diameter).	45	0	do	Most of columns failed due to spreading collapse.
Third floor: (12-inch, approximate) Concrete with wood finish.	73	0	do	
Second floor: (12-inch, approximate) Concrete with wood finish.	73	0	do	
First floor: (12-inch, approximate) Concrete with wood finish.	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete (10-inch)	0	0		
Interior walls: Concrete (8-inch)	0	0		
Windows	0	100	Blast and fire.	
Finish	0	100	do	
Contents: Cafeteria occupied part of first floor. Remainder of building, offices.	0	100	do	Entirely burned out. Do.

Remarks: One direct hit and one very near miss cracked floors and columns and started collapse. Fire affected exposed reinforcing rods and caused still more collapse. All damage due to high-explosive bombs

# DAMAGE ANALYSIS

Dimensions: a1, 550 by 53 feet; a2, 550 by 60 feet;  
and b, 525 by 58 feet.  
Ground floor area: 92,500 square feet.  
Total area: 92,500 square feet.  
Number of floors: 1.  
Eave height: 50 feet (all sections).  
Mean elevation: 15 feet.

Group 52.  
Building No.: 15a1, a2, and b.  
Occupancy: Boiler shop.  
Building type: Steel-frame, heavy cranes (B).  
Fire classification: N.  
Ground zero: 11,000 feet.

Construction	Damage			Description of damage
	Structural (per cent)	Superficial (per cent)	Cause	
Roof: a1, corrugated asbestos and a2, b, corrugated metal. Steel purlins throughout.	0	80	Blast and fragments.	Most of roof stripped by high explosives. Some damage to atomic bomb.
Trusses: Steel	18	0	do	Trusses at south end of building badly distorted and broken.
Columns: Steel	2	0	do	Two columns badly distorted by very close explosion.
First floor: Concrete	2	0	do	One bomb detonated on floor causing 10-foot crater and displacing foot of column.
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	60	Blast and fragments.	Most of damage due to a high explosive. A very small amount caused by atomic bomb.
Windows	0	60	do	Most of windows blown out by high explosives.
Contents: Hydraulic presses, heavy machine tools, welding equipment.				See note below.

Remarks: Of the 88 machine tools in the entire boiler shop approximately 40 percent were heavily damaged. About half of these were in Sections a1, a2, and b. All this damage was caused by high explosives. Photos 255, 256, 257, 259, and 260.

# DAMAGE ANALYSIS

Dimensions: 500 by 42 feet.  
Ground floor area: 17,200 square feet.  
Total area: 34,400 square feet.  
Number of floors: 2.  
Eave height: 50 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 15c.  
Occupancy: Boiler shop.  
Building type: Steel-frame, multistory (E2).  
Fire classification: N.  
Ground zero: 11,000 feet.

Construction	Damage			Description of damage
	Structural (per cent)	Superficial (per cent)	Cause	
Roof: Corrugated metal, steel purlins.	0	90	Blast and fragments.	
Trusses: Steel	10	0	Blast	Trusses bent by deflection of supporting columns.
Columns: Steel	0	0		
Second floor: Concrete	10	0	Blast and fragments.	High-explosive bomb detonated in section near level of 2d floor causing considerable damage.
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Windows		80	Blast	Windows blown out of south end of building.
Contents: Light and heavy machine tools.	0	20		Machine tools damaged by fragments.

Remarks: Almost all structural damage in this building was due to deflection of columns. These columns were bent near the second floor level, the distortion being great enough to affect the roof trusses.

# DAMAGE ANALYSIS

Dimensions: 400 by 56 feet.  
Ground floor area: 22,400 square feet.  
Total area: 22,400 square feet.  
Number of floors: 1.  
Eave height: 50 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 15d.  
Occupancy: Boiler shop.  
Building type: Steel-frame, light crane (B2).  
Fire classification: N.  
Ground zero: 11,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal, steel purlins.	0	100	Blast	Mostly due to column deflection. Two columns bent by near explosions; others damaged by blast of near-misses delaminating exterior walls.
Trusses: Steel	50	0	Blast, fragments, debris.	
Columns: Steel	15	0	Blast and fragments.	
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Windows	0	100	Blast	
Contents: Metal shears, hydraulic presses.	0	40		Machine tools damaged by fragments.

# DAMAGE ANALYSIS

Dimensions: 75 by 23 feet.  
Ground floor area: 1,700 square feet.  
Total area: 3,500 square feet.  
Number of floors: 2.  
Eave height: 20 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 15e.  
Occupancy: Not in use.  
Building type: Steel-frame, multistory (E1).  
Fire classification: N.  
Ground zero: 11,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
Second floor: Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: No covering	0	0		

Remarks: Section e once extended almost the full length of Building 15 but most of it was taken down before the attacks.

# DAMAGE ANALYSIS

Dimensions: 16 by 56 feet; 25 by 12 feet; 75 by 56 feet.  
Ground floor area: 4,700 square feet.  
Total area: 4,700 square feet.  
Number of floors: 1.  
Eave height: 16 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 15f.  
Occupancy: Hydraulic equipment for boiler shop.  
Building type: Steel-frame (D).  
Fire classification: N.  
Ground zero: 11,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated metal	0	0		
Trusses: Steel	0	0		
Columns: Steel	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Contents: Pumps and tanks	0	0		

# DAMAGE ANALYSIS

Dimensions: 138 by 60 feet.  
Ground floor area: 8,300 square feet.  
Total area: 16,000 square feet.  
Number of floors: 2.  
Eave height: 25 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 16a.  
Occupancy: Storage.  
Building type: Steel-frame, multistory (E2).  
Fire classification: C and N.  
Ground zero: 10,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Steel purlins; corrugated metal	0	100	Blast	Caused by atomic bomb blast. Photo 256.
Trusses: Steel	0	0		
Columns: Steel	5	0	Blast	Columns displaced at foot by cratering action of very near miss.
Second floor: Wood	0	0		
First floor: Concrete	0	5	Blast	Floor slabs cracked by cratering action of bomb.
Foundation: Concrete	5	0	do	Foundation broken by crater.
Exterior walls: Corrugated metal	0	10	do	Mostly due to HE.
Windows	0	30	do	Atomic bomb blew out some windows on north side.
Contents: Miscellaneous			Unknown	

Remarks: Sheet piling on north wall of building was almost all bent by blast of atomic bomb, but very little of it was stripped off.

# DAMAGE ANALYSIS

Dimensions: 213 by 60 feet.  
Ground floor area: 12,800 square feet.  
Total Area: 38,400 square feet.  
Number of floors: 3.  
Eave height: 38 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 16b.  
Occupancy: Storage.  
Building type: Steel-frame, multistory (E2).  
Fire classification: C and N.  
Ground zero: 10,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Steel purlins; corrugated metal.	0	100	Blast	Entirely due to atomic bomb.
Trusses: Steel	0	0		
Columns: Steel	0	0		
Third floor: Wood	0	0		
Second floor: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Corrugated metal	0	0		
Windows	0	20	Blast	Windows on north side broken by atomic bomb.
Contents: Miscellaneous			Unknown	

Remarks: Exterior wall sheeting on north side distorted but not stripped by atomic bomb.

# DAMAGE ANALYSIS

Dimensions: 314 by 40 feet.  
Ground floor area: 12,600 square feet.  
Total area: 25,200 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 17a1.  
Occupancy: Offices.  
Building type: Reinforced concrete, multistory, frame (E2).  
Fire classification: R.  
Ground zero: 11,300 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 2 1/2-inch concrete slab supported on 6- by 10-inch steel I-beams.	15	0	Blast, fragments, debris.	Two direct hits blew off portions of roof. Many trusses and columns were damaged when walls were blown in by near-misses. Others were damaged by direct hits.
Trusses: Concrete beams 12- by 14-inches.	60	0	Blast and fragments.	
Columns: Concrete 14- by 14-inches by 7 feet 6 inches.	70	0	do.	
Second floor: Concrete (5 inches thick).	50	0	do.	Much of walls damaged by near-misses.
First floor: Concrete	30	0	do.	
Foundation: Concrete	0	0	do.	
Exterior walls: Concrete (8 inches thick).	60	0	Blast and fragments.	
Windows	0	100	do.	

Remarks: This building will require complete rebuilding.

# DAMAGE ANALYSIS

Dimensions: 216 by 40 feet.  
Ground floor area: 8,600 square feet.  
Total area: 17,200 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 17a2.  
Occupancy: Kitchens.  
Building type: Multistory, wood-and-concrete frame (E2).  
Fire classification: C and R.  
Ground zero: 11,200 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Tile on wood sheeting	0	100	Blast, fragments, fire.	Roof completely destroyed by direct hit and fire spread. Photo 262.
Trusses: Wood	100	0	do	A few columns damaged by direct hit.
Columns: Concrete	8	0	Blast and fragments.	
Second floor: Concrete	10	0	do	Direct hit blew out portions of walls.
First floor: Concrete	0	0	do	
Exterior walls: Concrete	5	0	Blast	
Windows	0	100	Blast, fragments, fire.	
Contents: Kitchen equipment	0	70	Blast and fire	

Remarks: Fire burned through almost all of building. Fire did not originate at point of bomb detonation but spread into building from Sections "b" and "c."

# DAMAGE ANALYSIS

Dimensions: 64 by 40 feet.  
Ground floor area: 2,600 square feet.  
Total area: 5,200 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 17b.  
Occupancy: Storage.  
Building type: Multistory, brick wall-bearing (F2).  
Fire classification: C and N.  
Ground zero: 11,000 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Completely destroyed. Probably tile on wood sheeting.	0	100	Blast and fire	
Trusses: Wood	100	0	do	
Second floor: Concrete	100	0	Blast	
First floor: Concrete	50	0	do	
Foundation: Concrete	0	0		
Exterior walls: Brick	100	0	Blast	
Windows	0	100		
Contents: Unknown	0	100		

Remarks: Building completely destroyed by direct hit and fire. Debris had been cleared before arrival of field team.

# DAMAGE ANALYSIS

Dimensions: 140 by 54 feet.  
Ground floor area: 7,600 square feet.  
Total area: 7,600 square feet.  
Number of floors: 1.  
Eave height: 18 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 17c.  
Occupancy: Storage.  
Building type: Wall-bearing (D).  
Fire classification: C and N.  
Ground zero: 10,900 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Tile on wood sheeting	0	100	Blast and fire	Portions of roof blown down by bombs on other sections, then entire roof burned. See note above. Photo 269.
Trusses: Wood	100	0	do	
Columns: Brick (22 by 18 inches by 12 feet).	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	15	0	Blast	Portions of walls destroyed by bombs on Sections "b" and "d".
Windows	0	100	Blast and fire	
Finish	0	100	Fire	
Contents: Steel cable, motors, heavy tools, etc.	0	100	do	

# DAMAGE ANALYSIS

Dimensions: 346 by 58 feet.  
Ground floor area: 32,400 square feet.  
Total area: 98,200 square feet.  
Number of floors: 3.  
Eave height: 44 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 17d.  
Occupancy: Offices.  
Building type: Multistory, reinforced-concrete frame (E1).  
Fire classification: R.  
Ground zero: 10,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Concrete	0	0	Blast and fragments.	Only one small hole in roof.
Trusses: Concrete beams	20	0		HE bomb exploded between 2nd and 3rd floors, cracking beams in both floors.
Columns: Concrete	10	0	do	Columns cracked near point of detonation. No collapse.
Third floor: Concrete	20	0	do	Third floor was lifted by blast and then fell onto 2nd floor.
Second floor: Concrete	20	0	Debris	Twenty-five-foot hole blown in floor by bomb. Debris from third floor contributed to cracking of large area.
First floor: Concrete	0	0	Blast and fire	Spread of fire through building. Fire burned throughout top floors and through almost all of ground floor, destroying contents and finish.
Foundation: Concrete	0	0		
Exterior walls: Concrete	0	0		
Interior walls: Wood	0	90		
Windows	0	90		
Finish	0	90	do	
Contents: Office furniture	0	90	do	

Remarks: All damage due to HE bomb. Construction similar to Building 20. Photos 265 and 270.

# DAMAGE ANALYSIS

Dimensions: a—157 by 61 feet; b—38 by 30 feet;  
32 by 31 feet.  
Ground floor area: 12,300 square feet.  
Total area: 73,800 square feet.  
Number of floors: 6.  
Eave height: 82 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 18a, b.  
Occupancy: Offices.  
Building type: Multistory, reinforced-concrete frame (E1).  
Fire classification: R.  
Ground zero: 10,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Concrete	0	0	Blast	Windows on north and east sides blown in by atomic bomb.
Trusses: Concrete beams	0	0		
Columns: Concrete	0	0		
Fourth floor: Concrete	0	0		
Third floor: Concrete	0	0		
Second floor: Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete	0	0		
Interior walls: Wood	0	0		
Windows	0	30		
Contents: Office furniture	0	0		

Remarks: Construction similar to Building 20.

# DAMAGE ANALYSIS

Dimensions: 99 by 38 feet.  
Ground floor area: 3,800 square feet.  
Total area: 7,600 feet.  
Number of floors: 2.  
Eave height: 44 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 18b.  
Occupancy: Offices.  
Building type: Multistory, frame (E1).  
Fire classification: R.  
Ground zero: 10,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Concrete	0	0		
Trusses: Concrete beams	0	0		
Columns: Concrete	0	0		
Second floor: Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete	0	0		
Interior walls: Wood	0	0		
Contents: Office furniture	0	0		

Remarks: Similar to Building 20.

# DAMAGE ANALYSIS

Dimensions: 20 by 12 feet; 25 by 22 feet.  
Ground floor area: 800 square feet.  
Total area: 800 square feet.  
Number of floors: 1.  
Eave height: 12 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 18c.  
Occupancy: Not in use.  
Building type: Wall-bearing (D).  
Fire classification: C and N.  
Ground zero: 10,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood sheeting	0	0		
Trusses: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Brick	0	0		
Contents: Unknown				

# DAMAGE ANALYSIS

Dimensions: a—121 by 63 feet; b—72 by 63 feet.  
Ground floor area: 12,200 square feet.  
Total area: 36,600 square feet.  
Number of floors: 3.  
Eave height: 59 feet.  
Mean elevation: 15 feet.

Group 52.  
Building No. 19a, b.  
Occupancy: Offices.  
Building type: Multistory, frame (E1).  
Fire classification: R.  
Ground zero: 10,200 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Concrete	0	0		
Trusses: Concrete beams	0	0		
Columns: Concrete	0	0		
Third floor: Concrete	0	0		
Second floor: Concrete	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete	0	0		
Interior walls: Wood	0	30	Blast	
Windows	0	60	do	Windows blown out on north and south sides of the building. Some frames out on north side.
Contents: Office furniture	0	0		

Remarks: Construction similar to Building 20.

# DAMAGE ANALYSIS

Dimensions: 164 by 50 feet.  
Ground floor area: 8,200 square feet.  
Total area: 16,400 square feet.  
Number of floors: 2.  
Eave height: 35 feet.  
Mean elevation: 40 feet.

Group 52.  
Building No. 20.  
Occupancy: Offices.  
Building type: Multistory, frame (E1).  
Fire classification: R.  
Ground zero: 10,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Concrete (16 inches with surfacing)	0	0		
Trusses: Concrete beams (20 by 19 inches)	0	0		
Columns: Concrete (19 by 19 inches)	0	0		
Second floor: Concrete 7 inches	0	0		
First floor: Concrete 7 inches	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete 14 inches	0	0		
Interior walls: Wood	0	0		
Windows	0	70	Blast	All damage repaired before it was surveyed.
Contents: Office furniture	0	0		

<sup>1</sup> Estimated.

# DAMAGE ANALYSIS

Dimensions: 124 by 62 feet.  
Ground floor area: 7,700 square feet.  
Total area: 23,100 square feet.  
Number of floors: 3.  
Eave height: 59 feet.  
Mean elevation: 65 feet.

Group 52.  
Building No. 22.  
Occupancy: Laboratories.  
Building type: Multistory, reinforced-concrete frame (E1).  
Fire classification: R.  
Ground zero: 10,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Concrete	0	0		
Trusses: Concrete beams	0	0		
Columns: Ground floor 34 by 34 inches; concrete remainder 25 by 25 inches	0	0		
Third floor: Concrete 7 inches	0	0		
Second floor: Concrete 7 inches	0	0		
First floor: Concrete 7 inches	0	0		
Foundation: Concrete	0	0		
Exterior walls: Concrete 9 inches	0	30	Blast	Walls blown out on ground floor.
Interior walls: Wood studding and plaster	0	65	do	Almost all windows out on north side. Window frames bent.
Windows	0	0		
Contents: Mechanical and chemical testing equipment.	0	0		

# DAMAGE ANALYSIS

Dimensions: 90 by 66 feet.  
Ground floor area: 5,900 square feet.  
Total area: 11,800 square feet.  
Number of floors: 2.  
Eave height: 28 feet.  
Mean elevation: 60 feet.

Group 52.  
Building No. 23.  
Occupancy: Welding rod storage.  
Building type: Multistory, wood-frame (E2).  
Fire classification: C.  
Ground zero: 9,900 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile on wood sheeting	0	0		
Trusses: Wood	0	0		
Columns: Wood	0	0		
Second floor: Wood	0	0		
First floor: Concrete	0	0		
Foundation: Concrete	0	0		
Exterior walls: Wood	0	0		
Contents: Welding rods on wood racks.	0	0		

# Mitsubishi Dock Yard—Group 54

This group of buildings consisted of 5-steel-frame, 1 steel-and-concrete, 2 reinforced-concrete, and 4 wood-frame structures. They were located on the western side of the bay between 13,000 and 14,000 feet south of GZ. There was no structural damage to any of these buildings from the effects of the atomic bomb and the damage was

limited to broken glass and displaced roofing and siding.

b. Previous to the atomic attack, one reinforced-concrete building (No. 12) had been partly destroyed by a direct hit of a 500-pound, high-explosive bomb (Photo 283). Further details in connection with this group are shown on Figure 39, damage analysis sheets following, and Photos 272 to 283, inclusive.

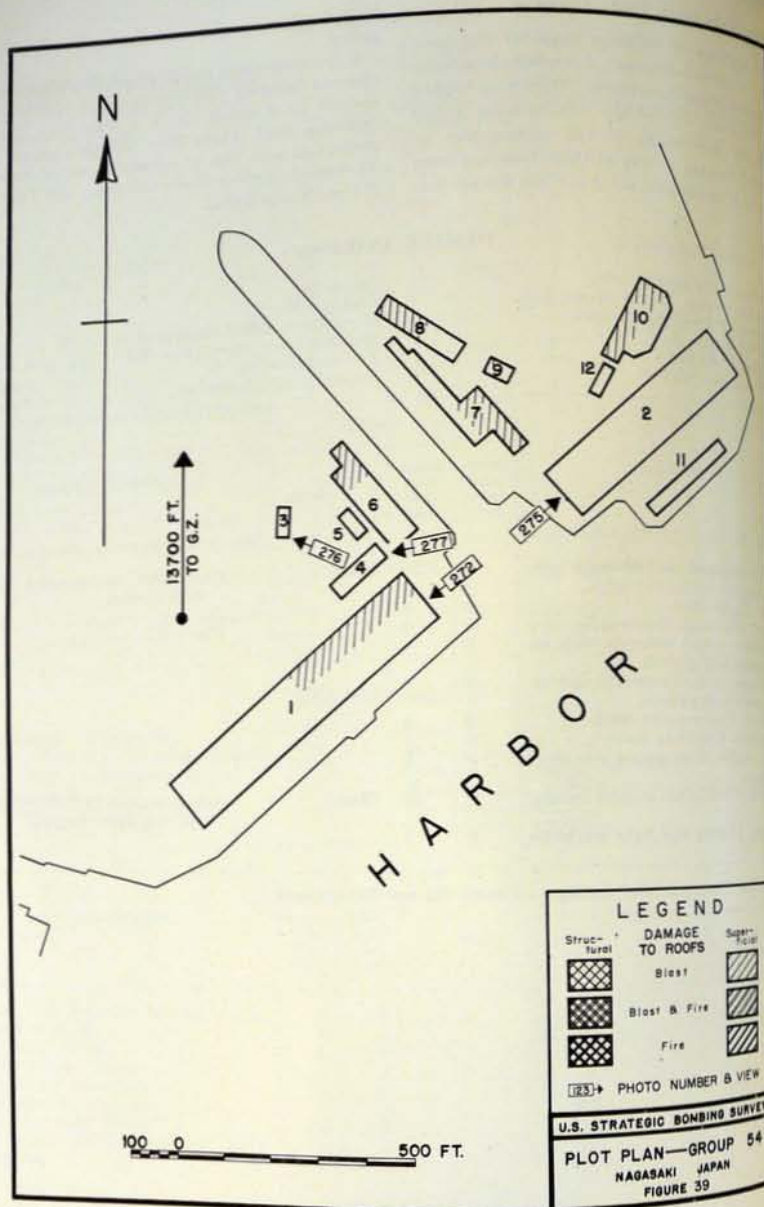
# DAMAGE ANALYSIS

Dimensions: 114 by 627 feet.  
Ground floor area: 71,478 square feet.  
Total area: 214,434 square feet.  
Number of floors: 3.  
Eave height: 62 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 1.  
Occupancy: Wood-working shop.  
Building type: Steel-frame (E2).  
Fire classification: N.  
Ground zero: 13,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins	0	20	Blast	Corrugated iron loosened from steel purlins.
Trusses: Light steel	0	0		
Columns: Built-up lattice-type steel	0	0		
Third floor: 4-inch concrete slab on steel joist and girders	0	0		
Second floor: 4-inch concrete slab on steel joist and girders	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Corrugated iron steel frame	0	0		
Windows: Plain glass in steel frames	0	50	Blast	Approximately half of window and roof lights broken.
Contents: Heavy and light machines	0	0		

Remarks: No structural damage. Photos 272 and 273 (typical).



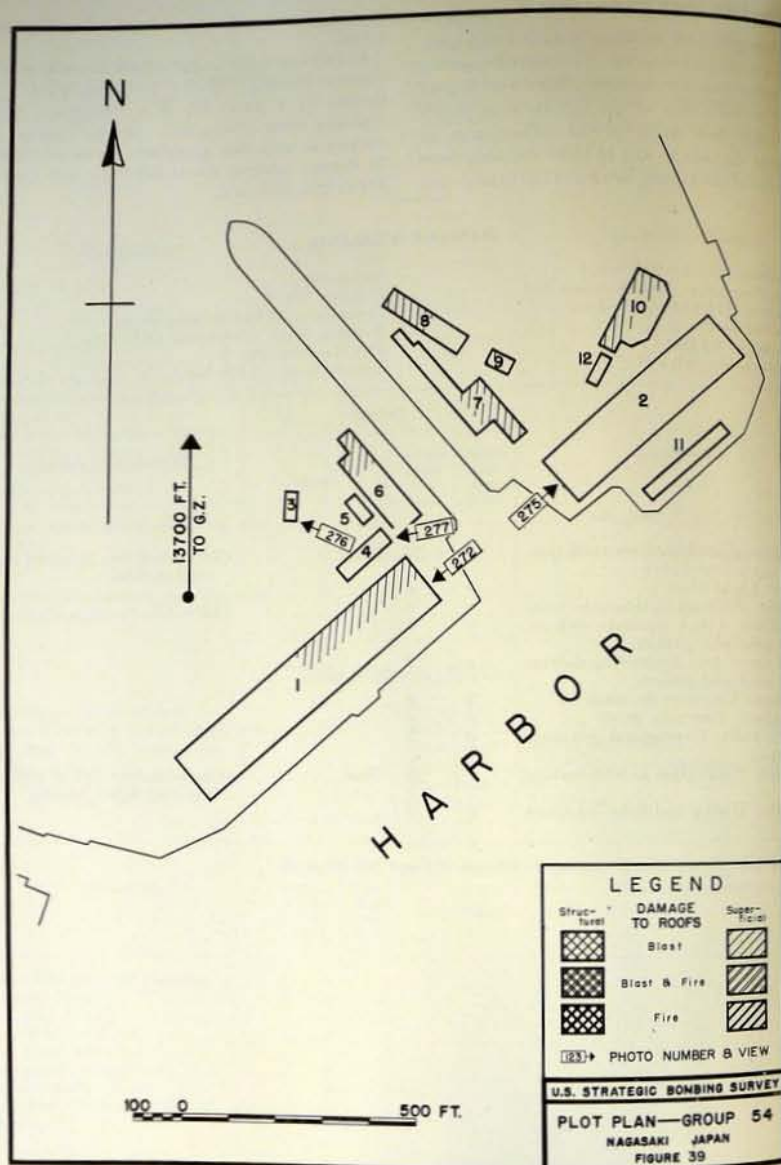
## DAMAGE ANALYSIS

Dimensions: 114 by 446 feet.  
Ground floor area: 50,844 square feet.  
Total area: 152,532 square feet.  
Number of floors: 3.  
Rave height: 62 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 2.  
Occupancy: Equipment shop.  
Building type: Steel-frame (E2).  
Fire classification: N.  
Ground zero: 13,500 feet.

Construction	Damage			Description of damage
	Struc- tural (per- cent)	Super- ficial (per- cent)	Cause	
Roof: Corrugated iron on steel pur- line.	0	0		Photo 274.
Trusses: Light steel.	0	0		
Columns: Built-up lattice-type steel.	0	0		
Third floor: 4-inch concrete slab on steel joist girders.	0	0		
Second floor: 4-inch concrete slab on steel joist girders.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	0		
Windows: Plain glass in steel frames.	0	0		
Contents: Light and heavy machine tools.	0	0		

Remarks: No structural damage. Photos 274 and 275.



Building 10 by 446 feet.  
 Building 11 by 514 square feet.  
 Building 12 by 532 square feet.  
 Building 13 by 51 feet.  
 Building 14 by 51 feet.  
 Building 15 by 19 feet.

Building 16 by 13,500 feet.  
 Fire classification: 13,500 feet.  
 Ground zero: 13,500 feet.

Construction	Damage			Description of damage
	Struc-tural (per-cent)	Super-ficial (per-cent)	Cause	
Corrugated iron on steel pur-chase steel	0	0		Photo 274.
4-inch lattice-type steel	0	0		
4-inch concrete slab on girders	0	0		
4-inch concrete slab on girders	0	0		
Concrete on earth	0	0		
Concrete piers	0	0		
Corrugated iron on steel frames	0	0		
Light and heavy machine	0	0		
	0	0		
	0	0		

No structural damage. Photos 274 and 275.

# DAMAGE ANALYSIS

Dimensions: 30 by 50 feet.  
Ground floor area: 1,500 square feet.  
Total area: 3,000 square feet.  
Number of floors: 2.  
Eave height: 40 feet.  
Mean elevation: 40 feet.

Group 54.  
Building No. 3.  
Occupancy: Radio laboratory.  
Building type: Steel-frame (E2).  
Fire classification: N.  
Ground zero: 13,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete slab roof on steel joist.	0	0		
Trusses: Light steel supporting roof slab.	0	0		
Columns: Built-up I space.	0	0		
Second floor: 4-inch concrete slab on steel frame.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Stone and concrete walls.	0	0		
Exterior walls: Corrugated asbestos on steel frame.	0	50	Blast	Siding broken and disposed from frame.
Windows: Clear glass in steel frame.	0	100		All glass broken.
Contents: Radio equipment.	0	0		

Remarks: No structural damage. Photo 276.

# DAMAGE ANALYSIS

Dimensions: 33 by 66 feet.  
Ground floor area: 2,178 square feet.  
Total area: 4,356 square feet.  
Number of floors: 2.  
Eave height: 40 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 4.  
Occupancy: Paint shop.  
Building type: Reinforced concrete (E2).  
Fire classification: R.  
Ground zero: 13,700 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: 3-inch reinforced concrete slab on steel girders.	0	0		
Trusses: Light steel.	0	0		
Columns: 22- by 22-inch reinforced concrete outside walls only.	0	0		
Second floor: 4-inch reinforced concrete slab on steel girders.	0	0		
First floor: Concrete slab on earth.	0	0		
Foundation: Concrete walls.	0	0		
Exterior walls: 6-inch reinforced concrete.	0	0		
Interior walls: Wood lath and plaster.	0	0		
Windows: Clear glass in wood frame.		100		All glass broken.
Floor: Plaster.	0	0		

Remarks: No structural damage. Photo 277.

# DAMAGE ANALYSIS

Dimensions: 22 by 66 feet.  
Ground floor area: 1,452 square feet.  
Total area: 2,904 square feet.  
Number of floors: 2.  
Eave height: 24 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 5.  
Occupancy: Paint warehouse.  
Building type: Reinforced concrete (E2).  
Fire classification: R.  
Ground zero: 13,700 feet.

Construction	Damage			Description of damage
	Structural (per cent)	Superficial (per cent)	Cause	
Roof: 4-inch reinforced concrete slab.	0	0		
Columns: 20- by 20-inch reinforced concrete.	0	0		
Second floor: 4-inch reinforced concrete slab.	0	0		
First floor: Concrete slab on earth.	0	0		
Foundation: Concrete walls.	0	0		
Exterior walls: 6-inch reinforced concrete and 20- by 20-inch reinforced concrete columns.	0	0		
Windows: Clear glass; wood frames—second floor only.	0	25	Blast	Glass broken.
Finish: Plaster.	0	0		
Contents: Paint stores.	0	0		

Remarks: No structural damage. Photo 278.

# DAMAGE ANALYSIS

Dimensions: 40 by 216 feet over-all.  
Ground floor area: 12,860 square feet.  
Total area: 25,720 square feet.  
Number of floors: 2.  
Eave height: 36 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 6.  
Occupancy: Storage.  
Building type: Steel-frame (E2).  
Fire classification: C.  
Ground zero: 13,600 feet.

Construction	Damage			Description of damage
	Structural (per cent)	Superficial (per cent)	Cause	
Roof: Corrugated iron on wood purlins.	0	25	Blast	Roofing stripped from purlins.
Trusses: Light steel.	0	0		
Columns: Built-up steel box lattice type.	0	0		
Second floor: Wood floor on steel girders.	0	0		
First floor: Concrete on earth.	0	0		
Basement.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	10	Blast	Siding stripped from steel frame. Photo 279.
Windows: Clear glass; metal frames.	0	10	do	Glass broken.
Contents: Miscellaneous storage.	0	0		

Remarks: No structural damage. Photo 279.

# DAMAGE ANALYSIS

Dimensions: 60 by 256 feet over-all.  
Ground floor area: 11,400 square feet.  
Total area: 34,200 square feet.  
Number of floors: 3.  
Eave height: 40 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 7.  
Occupancy: Storage.  
Building type: Steel-frame (E2).  
Fire classification: C.  
Ground zero: 13,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood purlins.	0	40	Blast	Approximately 40 percent loosened from purlins.
Trusses: Light steel	0	0		
Columns: Built-up steel box lattice type.	0	0		
Third floor: Wood flooring on steel girders.	0	0		
Second floor: Wood flooring on steel girders.	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete walls	0	0		
Exterior walls: Corrugated iron on steel frame.	0	40	Blast	Siding stripped from steel frame.
Windows: Clear glass; metal frames	0	50	do	Approximately 50 percent glass broken.
Contents: Miscellaneous storage	0	0		

Remarks: No structural damage. Photo 280.

# DAMAGE ANALYSIS

Dimensions: 45 by 200 feet.  
Ground floor area: 9,000 square feet.  
Total area: 18,000 square feet.  
Number of floors: 2.  
Eave height: 26 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 8.  
Occupancy: Warehouse.  
Building type: Wood-frame (E2).  
Fire classification: C.  
Ground zero: 13,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tile roofing, wood sheathing	0	50	Blast	Approximately half of roofing loosened by blast.
Trusses: Light wood	0	0		
Columns: 8- by 8-inch timber	0	0		
Second floor: Wood flooring on wood joist.	0	0		
First floor: Wood flooring on wood joist.	0	0		
Foundation: Concrete walls	0	0		
Exterior walls: Wooden siding on wood joist.	0	0		
Windows: Plain glass; wood frame	0	20	Blast	Glass broken.
Contents: Miscellaneous storage	0	0		

Remarks: No structural damage. Photo 281.

# DAMAGE ANALYSIS

Dimensions: 34 by 53 feet.  
Ground floor area: 1,802 square feet.  
Total area: 3,604 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 9.  
Occupancy: Warehouse.  
Building type: Steel-frame (E2).  
Fire classification: C.  
Ground zero: 13,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood purlins.	0	15	Blast	Roofing loosened from purlins.
Trusses: Light steel.	0	0		
Columns: Built-up I-shape steel.	0	0		
Second floor: Wood floor, steel girders.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete wall.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	15	Blast	Siding loosened from steel frame.
Windows: Plain glass in wood frames.	0	10	do	Glass broken.
Contents: General stores.	0	0		

Remarks: No structural damage. Photo 281.

# DAMAGE ANALYSIS

Dimensions: 75 by 195 feet over-all.  
Ground floor area: 10,937 square feet.  
Total area: 15,437 square feet.  
Number of floors: 1 and 2.  
Eave height: 22 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 10.  
Occupancy: Machine shop.  
Building type: Steel-frame (E2).  
Fire classification: N.  
Ground zero: 13,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	50	Blast	Roofing loosened from purlins.
Trusses: Light steel.	0	0		
Columns: Built-up I-shaped.	0	0		
Second floor: 3-inch concrete slab on steel beams.	0	0		
First floor: Concrete on earth.				
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	50	Blast	Siding loosened from frame.
Windows: Plain glass in steel frame.	0	50	do	Window and roof lights broken.
Contents: Machine tools.	0	0		

Remarks: No structural damage. Photo 282.

# DAMAGE ANALYSIS

Dimensions: 30 by 160 feet.  
Ground floor area: 4,800 square feet.  
Total area: 9,600 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 11.  
Occupancy: Equipment shop.  
Building type: Wood-frame (E2).  
Fire classification: C.  
Ground zero: 13,500.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood sheathing.	0	0		
Trusses: Light wood.	0	0		
Columns: 8- by 8-inch.	0	0		
Second floor: Wood flooring; wood joist.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete walls.	0	0		
Exterior walls: Wood siding on wood frame.	0	0		
Windows: Plain glass; steel frames.	0	50	Blast	Glass broken.
Contents: Light machine tools.	0	0		

Remarks: No damage except broken glass. Photo 275.

# DAMAGE ANALYSIS

Dimensions: 34 by 53 feet.  
Ground floor area: 1,802 square feet.  
Total area: 3,604 square feet.  
Number of floors: 2.  
Eave height: 22 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 9.  
Occupancy: Warehouse.  
Building type: Steel-frame (E2).  
Fire classification: C.  
Ground zero: 13,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood purlins.	0	15	Blast	Roofing loosened from purlins.
Trusses: Light steel	0	0		
Columns: Built-up I-shape steel	0	0		
Second floor: Wood floor, steel girders.	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete wall	0	0		
Exterior walls: Corrugated iron on steel frame.	0	15	Blast	Siding loosened from steel frame.
Windows: Plain glass in wood frames.	0	10	do	Glass broken.
Contents: General stores	0	0		

Remarks: No structural damage. Photo 281.

# DAMAGE ANALYSIS

Dimensions: 75 by 195 feet over-all.  
Ground floor area: 10,937 square feet.  
Total area: 15,437 square feet.  
Number of floors: 1 and 2.  
Eave height: 22 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 10.  
Occupancy: Machine shop.  
Building type: Steel-frame (E2).  
Fire classification: N.  
Ground zero: 13,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	50	Blast	Roofing loosened from purlins.
Trusses: Light steel	0	0		
Columns: Built-up I-shaped	0	0		
Second floor: 3-inch concrete slab on steel beams.	0	0		
First floor: Concrete on earth				
Foundation: Concrete piers	0	0		
Exterior walls: Corrugated iron on steel frame.	0	50	Blast	Siding loosened from frame.
Windows: Plain glass in steel frame	0	50	do	Window and roof lights broken.
Contents: Machine tools	0	0		

Remarks: No structural damage. Photo 282.

# DAMAGE ANALYSIS

Dimensions: 30 by 160 feet.  
Ground floor area: 4,800 square feet.  
Total area: 9,600 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 11.  
Occupancy: Equipment shop.  
Building type: Wood-frame (E2).  
Fire classification: C.  
Ground zero: 13,500.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on wood sheathing.	0	0		
Trusses: Light wood	0	0		
Columns: 8- by 8-inch	0	0		
Second floor: Wood flooring; wood joist.	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete walls	0	0		
Exterior walls: Wood siding on wood frame.	0	0		
Windows: Plain glass; steel frames	0	50	Blast	Glass broken.
Contents: Light machine tools	0	0		

Remarks: No damage except broken glass. Photo 275.

# DAMAGE ANALYSIS

Dimensions: 24 by 68 feet.  
Ground floor area: 1,632 square feet.  
Total area: 3,264 square feet.  
Number of floors: 2.  
Eave height: 28 feet.  
Mean elevation: 10 feet.

Group 54.  
Building No. 12.  
Occupancy: Electric equipment.  
Building type: Reinforced concrete and steel (E2).  
Fire classification: N.  
Ground zero: 13,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	0		See remarks.
Trusses: Light steel.	0	0		
Columns: 16- by 18-inch reinforced concrete, first floor only.	0	0		
Second floor: 3-inch reinforced concrete slab on 12- by 24-inch reinforced concrete beams.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Reinforced concrete piers under columns.	0	0		
Exterior walls: 6-inch reinforced concrete walls between 16- by 18-inch reinforced concrete columns.	0	0		
Windows: Clear glass; metal frames.	0	0		
Finish: Plaster.	0	0		
Contents: Electrical equipment storage.	0	0		

Remarks: This building 25 percent destroyed by high-explosive bomb previous to atomic bomb raid. Little additional damage by atomic bomb. Photo 283.

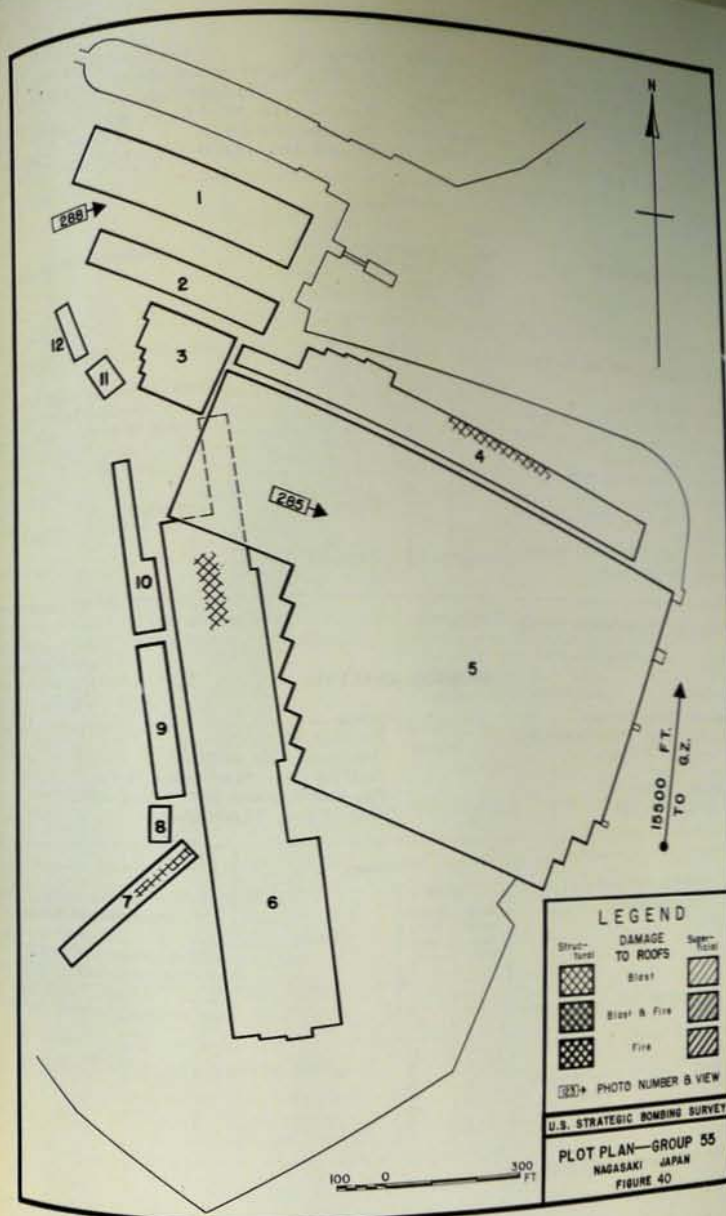
## 23. Tategami Shipyard—Group 55

a. This group consisted of 12 buildings located on the western shore of the bay between 14,200 and 16,000 feet south of GZ. The plant, known as the Tategami Shipyard, was owned by Mitsubishi. The 12 structures occupied a total ground area of approximately 10.5 acres, and consisted of 8 steel-frame and 4 reinforced-concrete buildings.

b. There was no structural damage and very little superficial damage caused by the atomic bomb. Further details in connection with this group are shown on Figure 40, the damage analysis sheets following, and Photos 284 and 288.

Building classification—Group 55

Building No.	Area		Type	Fire class	Steel frame	Concrete frame
	Plan (square feet)	Total (square feet)				
1	46,764	140,292	E1	N	X	X
2	18,600	18,600	A2.3	N	N	X
3	14,850	14,850	B2	N	N	X
4	44,400	44,400	B2	N	N	X
5	201,600	201,600	S	N	N	X
6	94,500	94,500	B2	N	N	X
7	12,500	12,500	B2	N	N	X
8	1,800	1,800	D	R	R	X
9	9,200	9,200	D	R	R	X
10	7,800	15,600	E1	N	N	X
11	1,500	3,000	E2	N	R	R
12	2,700	5,400	E2	N	R	R
Total	456,214	561,742			7	7



# DAMAGE ANALYSIS

Dimensions: 108 by 433 feet.  
Ground floor area: 46,764 square feet.  
Total area: 140,292 square feet.  
Number of floors: 3.  
Eave height: 50 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 1.  
Occupancy: Machine shop.  
Building type: Steel-frame (E1).  
Fire classification: N.  
Ground zero: 14,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	0		
Trusses: Heavy steel	0	0		
Columns: Built-up lattice box type	0	0		
Second floor: Wood floor on steel beams; concrete finish.	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete piers	0	0	Blast	Very slight.
Exterior walls: Corrugated iron on steel frame	0	5	do	
Windows: Plain glass; steel frames	0	0		
Contents: Machine tools				

Remarks: No structural damage. Photo 288.

# DAMAGE ANALYSIS

Dimensions: 60 by 310 feet.  
Ground floor area: 18,600 square feet.  
Total area: 18,600 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 2.  
Occupancy: No evidence.  
Building type: Steel-frame (A2.3).  
Fire classification: N.  
Ground zero: 14,600 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	0		
Trusses: Light steel	0	0		
Columns: Steel	0	0		
First floor: Wood on wood sleepers	0	0		
Foundation: Concrete piers	0	0		
Contents: No evidence	0	0		

Remarks: Open-sided building. No damage.

# DAMAGE ANALYSIS

Dimensions: 110 by 135 feet.  
Ground floor area: 14,850 square feet.  
Total area: 14,850 square feet.  
Number of floors: 1.  
Eave height: 25 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 3.  
Occupancy: Plate shop.  
Building type: Reinforced concrete (B2).  
Fire classification: R.  
Ground zero: 14,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete slab steel ties.	0	0		
Columns: Reinforced concrete	0	0		
First floor: Steel plates	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Open	0	0		
Contents: Machine tools	0	0		

Remarks: No damage.

# DAMAGE ANALYSIS

Dimensions: 60 by 740 feet.  
Ground floor area: 44,400 square feet.  
Total area: 44,400 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 4.  
Occupancy: Heavy machine shop.  
Building type: Steel-frame (B2).  
Fire classification: N.  
Ground zero: 14,800 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron on steel purlins.	0	5	Blast	Loosened from purlins.
Trusses: Heavy steel	0	0		
Columns: Steel	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Open	0	0		
Contents: Heavy machine tools	0	0		

Remarks: Very slight superficial damage.

# DAMAGE ANALYSIS

Dimensions: 240 by 840 feet.  
Ground floor area: 201,600 square feet.  
Total area: 201,600 square feet.  
Number of floors: 1.  
Eave height: 100 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 5.  
Occupancy: Shipways.  
Building type: Steel-frame (S).  
Fire classification: N.  
Ground zero: 15,200 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: No roofing	0	0		Photos, aerial 284, 287.
Trusses: Heavy steel	0	0		
Columns: Heavy built-up lattice	0	0		
First floor: Earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: None	0	0		
Contents: Heavy cranes	0	0		

Remarks: No damage. Photos 284, 285, and 287.

# DAMAGE ANALYSIS

Dimensions: 135 by 700 feet.  
Ground floor area: 94,500 square feet.  
Total area: 94,500 square feet.  
Number of floors: 1.  
Eave height: 40 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 6.  
Occupancy: Assembly of midget submarines.  
Building type: Steel-frame (B2).  
Fire classification: N.  
Ground zero: 15,500 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Corrugated iron on wood purlins	0	5	Blast	Very slight.
Trusses: Heavy steel	0	0		
Columns: Heavy built-up lattice type	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Corrugated iron on steel and wood framing	0	5	Blast	Do.
Windows: Plain glass; steel frames	0	25	do	
Contents: Overhead cranes	0	0		

Remarks: No structural damage. Open crane frames at south of building. Photo 286.

# DAMAGE ANALYSIS

Dimensions: 50 by 250 feet.  
Ground floor area: 12,500 square feet.  
Total area: 12,500 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 7.  
Occupancy: Plate stores.  
Building type: Steel-frame (B2).  
Fire classification: N.  
Ground zero: 15,800 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Corrugated iron	0	5	Blast	Roofing displaced very slightly.
Trusses: Steel	0	0		
Columns: Built-up lattice box type	0	0		
First floor: Earth	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Corrugated iron; steel frame	0	5	Blast	Slight displacement.
Windows: Plain glass; steel frames	0	25	do	
Contents: Light machine tools	0	0		

Remarks: No structural damage. All damage repaired at time of survey.

# DAMAGE ANALYSIS

Dimensions: 30 by 60 feet.  
Ground floor area: 1,800 square feet.  
Total area: 1,800 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 8.  
Occupancy: Warehouse.  
Building type: Reinforced concrete (D).  
Fire classification: R.  
Ground zero: 15,500 feet.

Construction	Damage		Cause	Description of damage
	Structural (percent)	Superficial (percent)		
Roof: Reinforced concrete slab	0	0		Repaired.
Columns: Reinforced concrete	0	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete	0	0		
Exterior walls: Reinforced concrete	0	0		
Windows: Plain glass; metal frames	0	0		

Remarks: No damage except window glass.

# DAMAGE ANALYSIS

Dimensions: 40 by 230 feet.  
Ground floor area: 9,200 square feet.  
Total area: 9,200 square feet.  
Number of floors: 1.  
Eave height: 20 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 9.  
Occupancy: Blacksmith shop.  
Building type: Reinforced concrete (D).  
Fire classification: R.  
Ground zero: 15,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced concrete slab; steel tie rods.	0	0		
Columns: Reinforced concrete.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete walls and piers.	0	0		
Exterior walls: Reinforced concrete.	0	0		
Windows: Wire glass; steel frames.	0	0		
Contents: Blacksmith equipment.	0	0		

Remarks: No damage except to window glass.

# DAMAGE ANALYSIS

Dimensions: 30 by 260 feet.  
Ground floor area: 7,800 square feet.  
Total area: 15,600 square feet.  
Number of floors: 2.  
Eave height: 45 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 10.  
Occupancy: Not known.  
Building type: Steel-frame (E1).  
Fire classification: N.  
Ground zero: 15,100 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Corrugated iron.	0	0		
Trusses: Steel.	0	0		
Columns: Built-up lattice steel box type.	0	0		
Second floor: Wood flooring on steel beams.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete piers.	0	0		
Exterior walls: Corrugated iron on steel frame.	0	0		
Windows: Plain glass; steel frames.	0	0		

Remarks: No damage except to window glass.

# DAMAGE ANALYSIS

Dimensions: 30 by 50 feet.  
Ground floor area: 1,500 square feet.  
Total area: 3,000 square feet.  
Number of floors: 2.  
Eave height: 30 feet.  
Mean elevation: 5 feet.

Group 55.  
Building No. 11.  
Occupancy: Offices and switch gear.  
Building type: Reinforced concrete (E2).  
Fire classification: R.  
Ground zero: 15,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced-concrete arch slab; steel tie rods.	0	0		
Columns: Reinforced concrete.	0	0		
Second floor: Wood floor on concrete slab.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Concrete walls and piers.	0	0		
Exterior walls: Reinforced concrete.	0	0		
Interior walls: Wood lath and plaster on first floor.	0	0		
Windows: Plain glass; metal frames.	0	0		
Finish: Plaster.	0	0		
Contents: Switch gear and convertors.	0	0		

Remarks: Slight damage to window glass.

# DAMAGE ANALYSIS

Dimensions: 30 by 90 feet.  
Ground floor area: 2,700 square feet.  
Total area: 5,400 square feet.  
Number of floors: 2.  
Eave height: 5 feet.  
Mean elevation 5 feet.

Group 55.  
Building No. 12.  
Occupancy: Warehouse.  
Building type: Reinforced concrete (E2).  
Fire classification: R.  
Ground zero: 15,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Reinforced arch slab of concrete; steel tie rods.	0	0		
Columns: Reinforced concrete.	0	0		
Second floor: Reinforced-concrete slab.	0	0		
First floor: Concrete on earth.	0	0		
Foundation: Reinforced-concrete walls.	0	0		
Exterior walls: Combination reinforced concrete and corrugated iron.	0	0		
Windows: Plain glass in steel frames.	0	0		
Contents: Small parts stores.	0	0		

Remarks: No damage except to window glass.

#### 24. Otao Shipyard—Group 57.

a. This was a single shed-type building, 8 bays long, containing a midget submarine assembling industry. It was located 17,500 feet from GZ. It sustained minor superficial damage to windows and the north wall.

b. Additional construction and damage information is shown on the following damage analysis sheet.

#### 25. Kozaki Point Oil Storage—Group 58

a. Buildings and storage tanks made up this group which was located along the shore of Kozaki Point southwest of GZ between the limits of 17,000 and 20,000 feet. It consisted of 4 wood buildings, 8 steel-frame buildings, 6 brick-and-wood buildings, and 19 steel tanks of various sizes and capacities.

b. No damage was sustained by any of these structures from blast or fire from the atomic bomb, but one brick building with a wooden roof (No. 19) and one storage tank near by (No. 20) were damaged by a high-explosive bomb. Approximately 60 percent of the building roof and 50 percent of the east and south walls were structurally damaged. Photo 289 shows the damage

to Tank 20. No plot plan was drawn showing the location of the buildings in this group since very little damage to the structures was caused by the atomic bomb (Photos 289 to 293, inclusive).

#### 26. Nagasaki Tobacco Monopoly Agency—Group 71

This group of seven buildings constructed of wood lath and plaster with tile roofs was located 8,800 feet south of GZ, covering an area of approximately 21,000 square feet. Fire and blast demolished these buildings except for the concrete foundation walls.

#### 27. Dejima Wharf—Group 82

a. The seven buildings in this group were located between 10,700 feet and 11,800 feet south of GZ. They were constructed of timber framing with wood lath and plaster walls and covered an area of approximately 64,000 square feet.

b. Although the roofs of a few of the lighter structures were superficially damaged to a slight extent, no serious damage was sustained.

#### 28. Mitsubishi Trading Company—Group 87

This group consisted of two buildings and several small sheds covering an area of 20,000 square feet, located 14,300 feet south of GZ. One of the build-

ings was a two-story wooden warehouse, 100 by 100 feet with a saw-tooth roof. The other main building was a two-story wooden-frame house, 100 by 75 feet. No damage was sustained by any of the buildings (Photos 297 and 298).

#### 29. Mitsubishi Small Shipbuilding Works—Group 89

a. This group consisted of two two-story, steel-frame buildings, three one-story, steel-frame buildings, and one single-story wood-frame structure. The roofs and siding of all of these buildings were of corrugated iron. The first floors were concrete on earth, and the second floors of the two-story structures were wood on steel girders.

b. None of these buildings covered more than 4,000 square feet, and the total area covered by the six buildings was approximately 24,300 square feet.

c. These buildings were located between 16,200 and 16,800 feet south of GZ. The damage from the atomic bomb was minor, consisting of broken window glass and a small amount of displaced siding. Photos 294 and 295 show general views of these buildings.

#### 30. Mitsubishi Small Boat Yard—Group 90

This group consisted of several shed-type wooden structures of various heights. The roofs were of bamboo or corrugated iron on wood trusses supported on rough wood poles. These structures were located in a sheltered inlet on the east side of the bay, 18,800 feet south of GZ. A hill approximately 300 feet in height north of this site protected the buildings from the blast effects of the atomic bomb, and they were not damaged in any way. Photo 296 shows construction of these sheds.

#### 31. Torpedo Boat Manufacturing Plant—Group 92

a. Three main buildings and two small sheds made up this group which was located on the east side of the bay, 19,000 feet south of GZ. All the buildings were one story high and of light wood-frame construction. The total area covered was 57,500 square feet.

b. The north wall of the largest of these structures, located in the northwest corner of the area, collapsed for a distance of approximately 70 feet. This group was at the farthest point from GZ at which structural damage was noted.

c. Other damage at this site was minor, consisting only of broken glass.

### DAMAGE ANALYSIS

Dimensions: 600 by 250 feet.  
Ground floor area: 150,000 square feet.  
Total area: 150,000 square feet.  
Number of floors: 1.  
Eave height: 50, 35, and 25 feet.  
Mean elevation: 10 feet.

Group 57.  
Building No. 1.  
Occupancy: Storage and assembly of midget submarines.  
Building type: Wood, concrete, and steel (B2).  
Fire classification: C.  
Ground zero: 17,500 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Wood	0	0		
Columns: Steel and reinforced concrete	0	0		
First floor: Wood and reinforced concrete	0	0		
Exterior walls: Wood	0	5	Blast	Slight distortion on north side only.
Windows: Wood sash	0	5	do	

### DAMAGE ANALYSIS

Dimensions: 120 by 235 feet.  
Ground floor area: 28,200 square feet.  
Total area: 28,200 square feet.  
Number of floors: 1.  
Eave height: 14 feet.  
Mean elevation: 10 feet.

Group 92.  
Building No. 1.  
Occupancy: Storage and assembly.  
Building type: Wood frame (A 2.3).  
Fire classification: C.  
Ground zero: 19,000 feet.

Construction	Damage			Description of damage
	Structural (percent)	Superficial (percent)	Cause	
Roof: Tar paper on wood sheathing	0	10	Blast	
Trusses: Light wood	8	0		
First floor: Concrete on earth	0	0		
Foundation: Concrete piers	0	0		
Exterior walls: Wood siding on wood frame	0	0		
Contents: Light machine tools	0	0		

### 32. Nippon Oil Company—Group 93

a. This group consisted of seven small one-story buildings constructed of brick and concrete with steel trusses and corrugated-iron roofs. There were also two storage tanks and a small boom crane for unloading oil drums. The seven buildings covered a total area of approximately 7,000 square feet and were located on an inlet on the east side of the bay, 18,700 feet south of GZ.

b. Approximately 10 percent of the corrugated iron roofing was loosened by the atomic bomb, and 25 percent of the windows were broken by

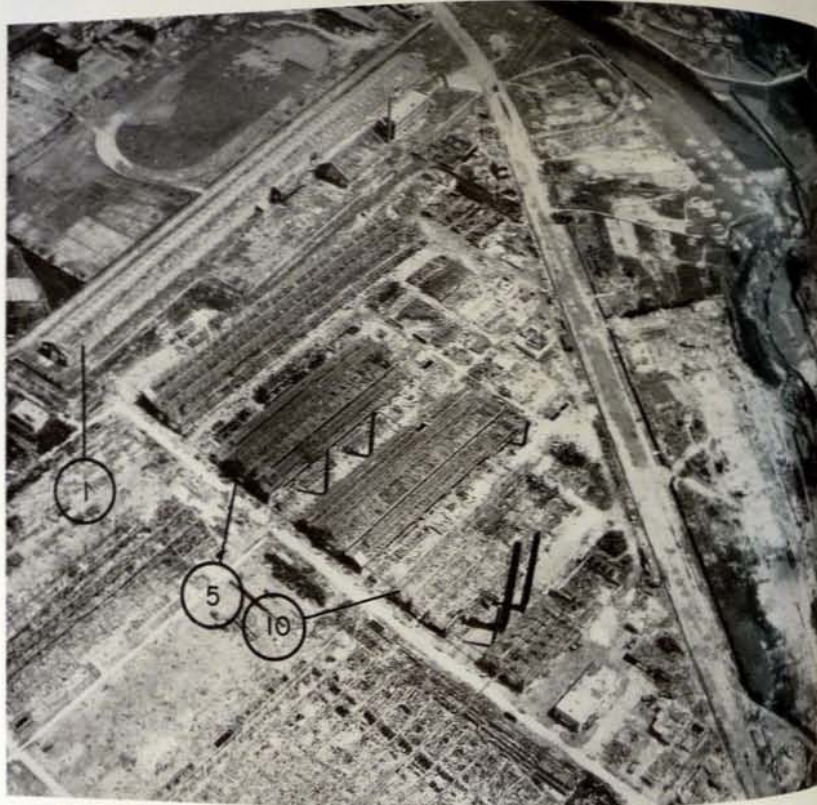


Photo 1.—5,000 feet from GZ. Group 4. Mitsubishi Torpedo Works. Aerial view looking northeast.

blast. There was no structural damage to buildings.

### 33. Powder Magazine—Group 94

This group of three buildings was located 20,000 feet south of GZ in a valley 1,500 feet east of the bay. The buildings were each 20 by 30 feet, and were constructed of reinforced concrete with a steel-truss roof frame covered with concrete with a buildings were 14 feet to their eaves, and each was surrounded by earth banked 30 feet high and 40 feet thick at the base. There was no damage of any kind to these structures.

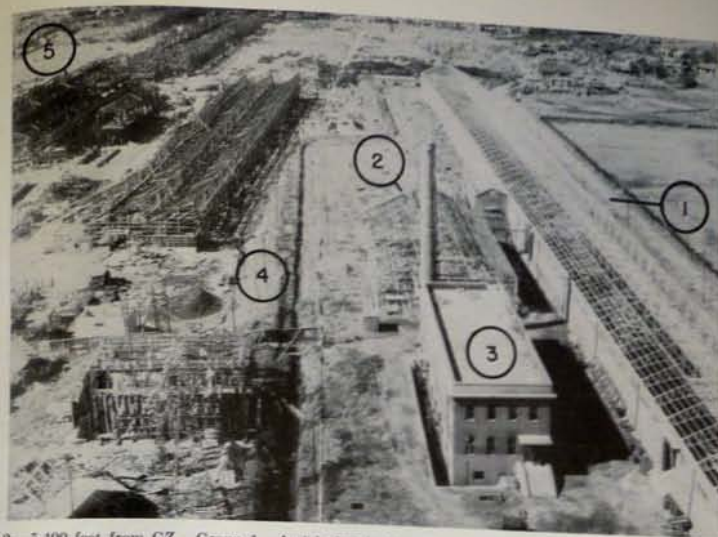


Photo 2.—5,400 feet from GZ. Group 4. Aerial view looking west at north portion of Mitsubishi Torpedo Works.



Photo 3.—3,900 feet from GZ. Group 4. Building 28. Aerial view looking northwest.

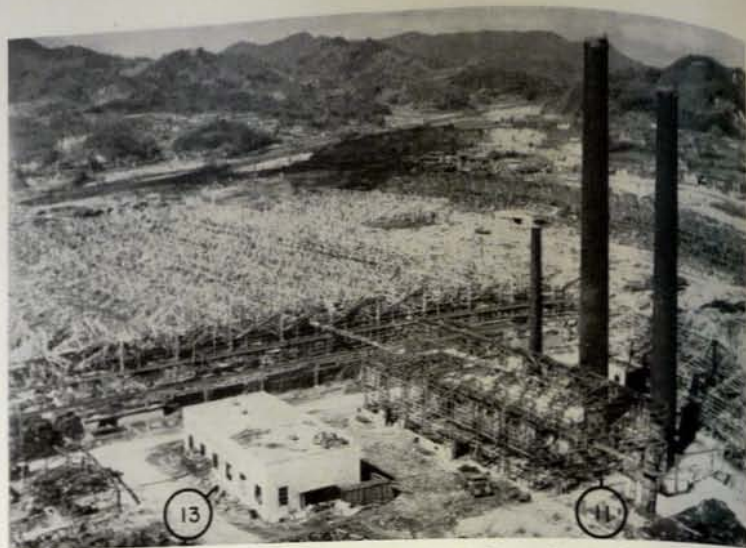


PHOTO 4.—4,500 feet from GZ. Group 4. Building 22. Aerial view looking northwest. Building 11 (boiler house) in foreground.



PHOTO 5.—4,500 feet from GZ. Group 4. Building 22. Aerial view east.



PHOTO 6.—5,100 feet from GZ. Group 4. Aerial view looking east at north portion of Mitsubishi Torpedo Works.



PHOTO 7.—5,500 feet from GZ. Group 4. Building 1, looking west.



PHOTO 8.—5,500 feet from GZ. Group 4. Building 1, looking west, wall failure.



Photo 9.—5,500 feet from GZ. Group 4. Building 1. Typical column failure, north wall inside.



Photo 10.—5,500 feet from GZ. Group 4. Building 1. Typical column failure, south wall inside.



Photo 12.—5,500 feet from GZ. Group 4. Building 1. Separation at Switch House wall.



Photo 14.—5,500 feet from GZ. Group 4. Building 1. Typical wall failure, top and bottom.



Photo 11.—5,500 feet from GZ. Group 4. Building 1. Typical wall failure bottom of south wall outside.



Photo 13.—5,500 feet from GZ. Group 4. Building 1. Crack in north wall looking southwest.



Photo 15.—5,500 feet from GZ. Group 4. Building 1. Separation at Pump House wall.

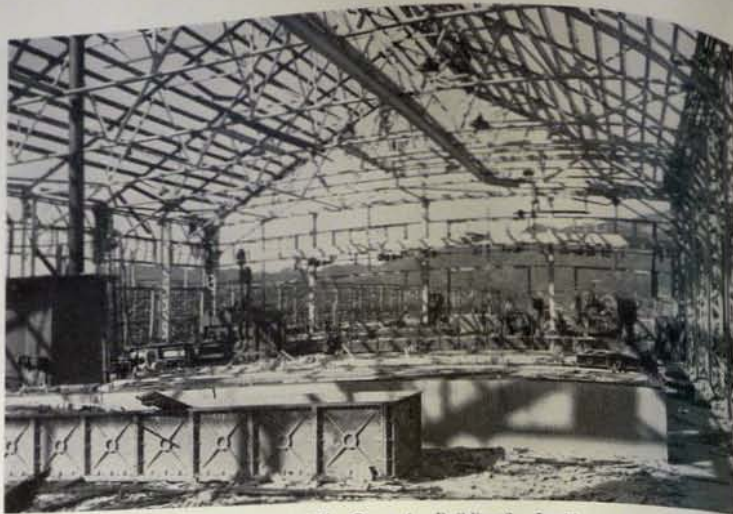


PHOTO 16.—5,400 feet from GZ. Group 4. Building 2. Looking west.



PHOTO 17.—5,400 feet from GZ. Group 4. Building 3. Looking northwest.



PHOTO 18.—5,400 feet from GZ. Group 4. Building 3. Structural features 2d floor looking west.



PHOTO 19.—5,100 feet from GZ. Group 4. Building 4. Looking northwest.



PHOTO 20.—5,000 feet from GZ. Group 4. Building 4. Electric clock.



PHOTO 21.—5,000 feet from GZ. Group 4. Building 5. Main columns looking west.



PHOTO 22.—5,000 feet from GZ. Group 4. Building 5. North row of columns, looking west.

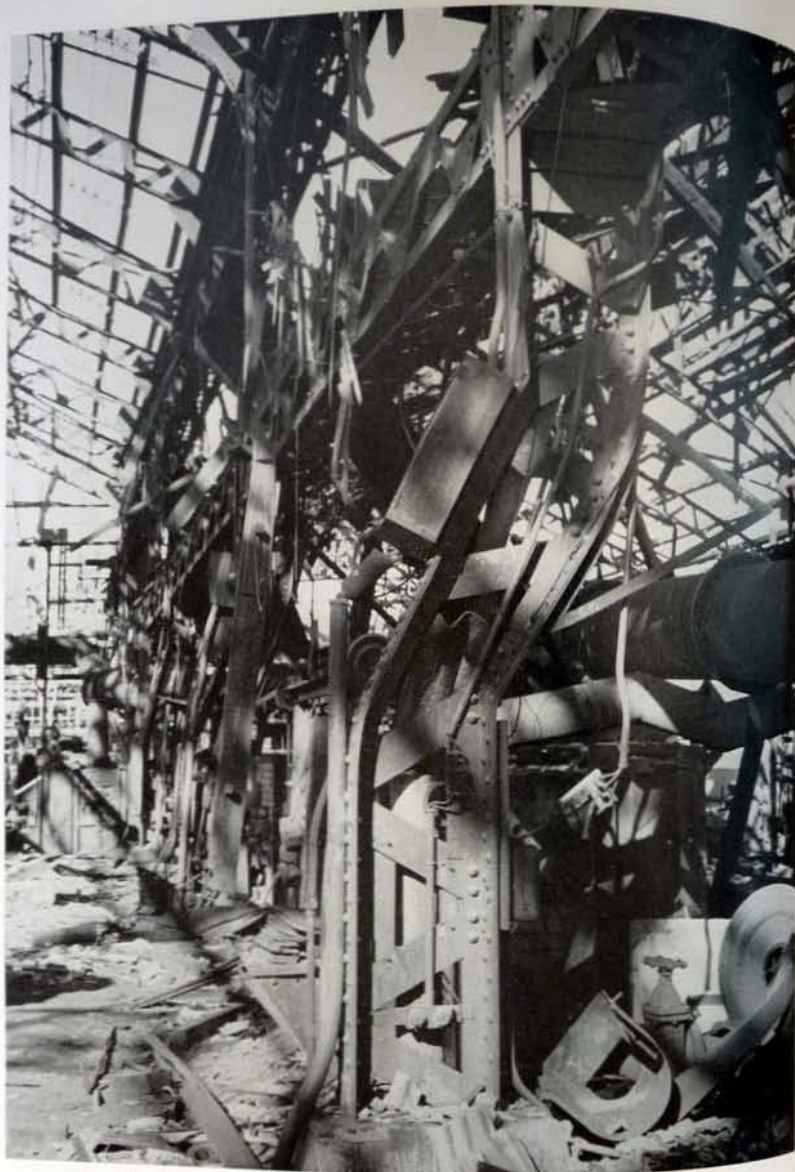


PHOTO 23.—5,000 feet from GZ. Group 4. Building 5. Close-up main columns, looking west.



PHOTO 24.—5,000 feet from CZ. Group 4. Building 5. General features and equipment, looking west.



PHOTO 25.—5,000 feet from GZ. Group 4. Building 5. General features and equipment, looking west.



PHOTO 26.—4,800 feet from GZ. Group 4. Building 5A, looking southwest.



PHOTO 27.—5,000 feet from GZ. Group 4. Building 5. Column 4-C showing cracked foundation.



PHOTO 28.—5,000 feet from GZ. Group 4. Building 5. Column 4-A.



PHOTO 29.—4,600 feet from GZ. Group 4. Building 10, looking northwest.



PHOTO 30.—4,400 feet from GZ. Group 4. Building 11, looking west.



PHOTO 31.—5,100 feet from GZ. Group 4. Building 20, looking northwest.



PHOTO 32.—4,800 feet from GZ. Group 4. Buildings 7, 8, and SA looking southwest.



PHOTO 33.—4,300 feet from GZ. Group 4. Building 13, structural features and equipment looking east.



PHOTO 41.—4,500 feet from GZ. Group 4. Building 22. Aerial view looking northwest.



PHOTO 42.—4,100 feet from GZ. Group 4. Building 25, looking northeast.



PHOTO 43.—3,900 feet from GZ. Group 4. Building 28, looking southwest.



PHOTO 44.—3,900 feet from GZ. Group 4. Building 28, looking northwest.

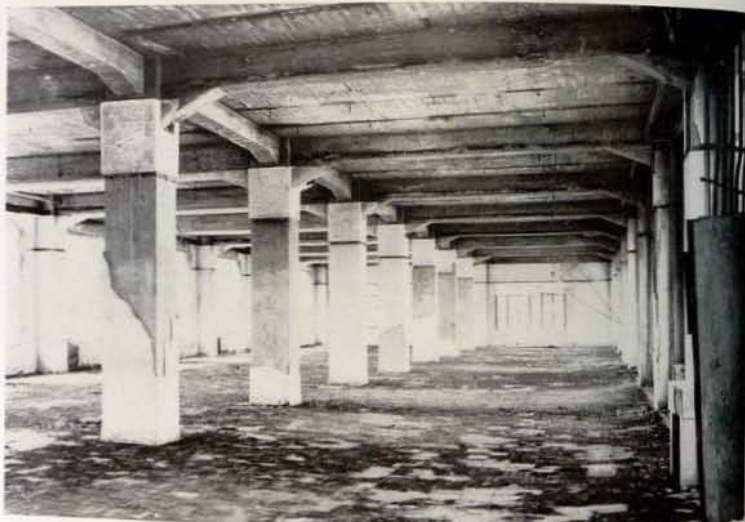


PHOTO 45.—3,900 feet from GZ. Group 4. Building 28, third floor looking west.



PHOTO 46.—3,900 feet from GZ. Group 4. Building 28, first floor buckled slab.



PHOTO 47.—3,900 feet from GZ. Group 4. Building 28, second floor looking west.



PHOTO 48.—4,200 feet from GZ. Group 4. Building 23, looking northwest.



PHOTO 49.—3,900 feet from GZ. Group 4. Building 28, first floor looking west.

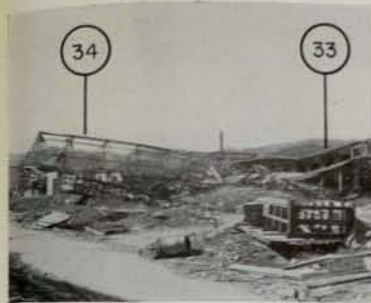


PHOTO 50.—4,300 feet from GZ. Group 4. Buildings 33 and 34, looking southwest.



PHOTO 51.—4,100 feet from GZ. Group 4. Building 34, looking west.

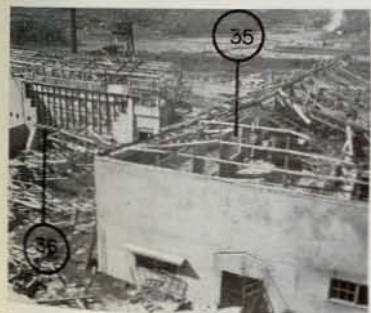


PHOTO 52.—3,900 feet from GZ. Group 4. Buildings 35 and 36, looking southwest.



PHOTO 53.—3,900 feet from GZ. Group 4. Building 28, burned flooring.



PHOTO 54.—3,200 feet from GZ. Group 5. Building 1. Looking northeast at margin of fire damage.



PHOTO 55.—Group 5. Building 1. General view looking northeast.



PHOTO 56.—Group 5. Building 1. Looking northeast toward north end.



PHOTO 57.—Group 5. Building 1. Typical failure at base of column.



PHOTO 58.—Group 5. Building 1. Flash burns on timber framing.



PHOTO 59.—3,200 feet from GZ. Group 5. Flash burns on blast wall.



PHOTO 60.—Group 5. Building 2. Looking north at debris.



PHOTO 61.—Group 5. Looking north at collapsed distribution towers.



Photo 62.—3,500 feet from GZ. Group 5. Building 3. Collapsed substation.



Photo 63.—3,200 feet from GZ. Group 5. Building 3. General view looking east.



Photo 64.—Group 5. Building 7. Roof slab overturned by blast.



Photo 65.—Group 5. Building 7. Looking north at overturned roof slab.



Photo 66.—3,200 feet from GZ. Ohashi Gas Works. View of gas holder damaged by blast of atomic bomb and low order detonation of contents.



Photo 67.—3,700 ft.—GZ. Coal hopper, looking west.



Photo 68.—3,700 feet from GZ. Group 6. Coking ovens under construction. Looking west.



Photo 69.—3,500 ft., GZ. Scrubbers—looking west.



Photo 70.—3,200 feet from GZ. Group 6. Damaged gas holder looking west.



Photo 71.—3,200 feet from GZ. Group 6. Damaged tank top.



Photo 72.—3,200 feet from GZ. Group 6. Damaged gas holder, looking east.



Photo 73.—3,200 feet from GZ. Group 6. Gas holder, ruptured top plates.



Photo 74.—3,200 feet from GZ. Group 6. Gas holder, collapsed framing.



Photo 75.—1,200 feet from GZ. General view of area included in Group 12. Ground Zero on upper right section of photo.



Photo 76.—1,200 feet from GZ. Area included in Group 12. Ground Zero at right of photo.



Photo 77.—1,500 feet from GZ. Group 12. View looking southeast at brick and concrete building near south end of group area.



Photo 78.—1,400 feet from GZ. Group 12. View looking southwest at concrete building near south end of group area.



PHOTO 79.—Group 12. General view looking northwest from Urakami River bridge.



PHOTO 80.—Group 12. General view looking south. Brick kilns in background.



PHOTO 81.—1,600 feet from GZ. Group 12. Looking east toward Nagasaki prison. Brick kiln at left of photo.

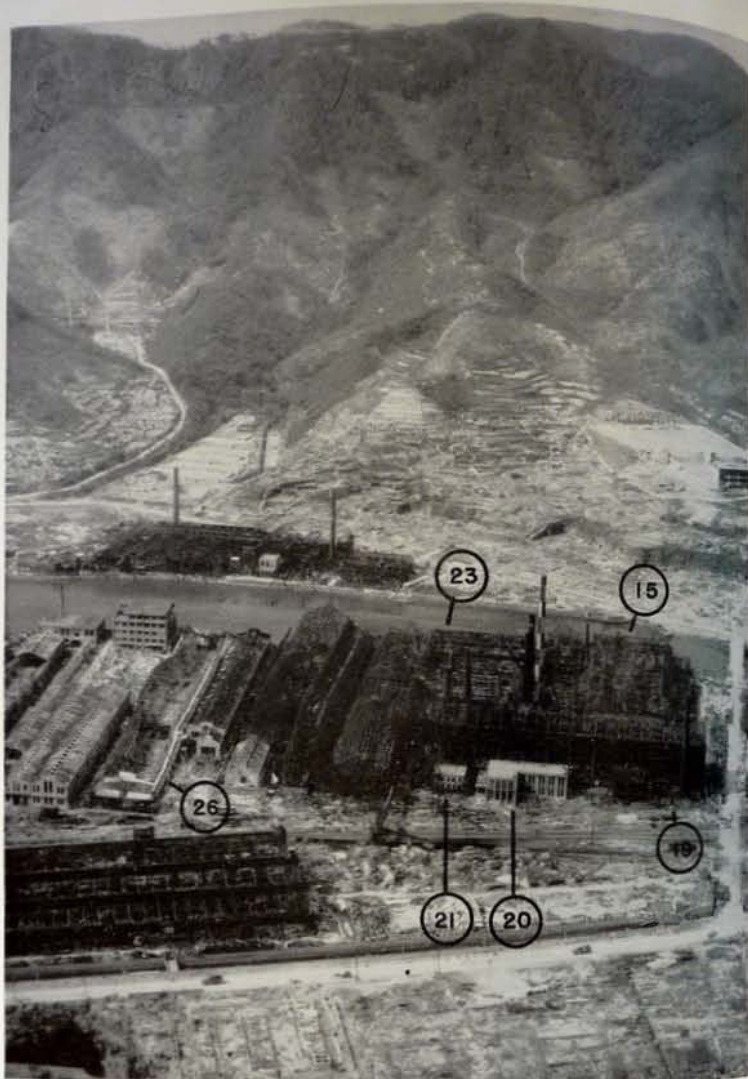


Photo 82.—4,000 feet from GZ. Group 26. Looking west at central portion of Mitsubishi Steel and Arms Works. Group 31 (casting plant) can be seen across the river.

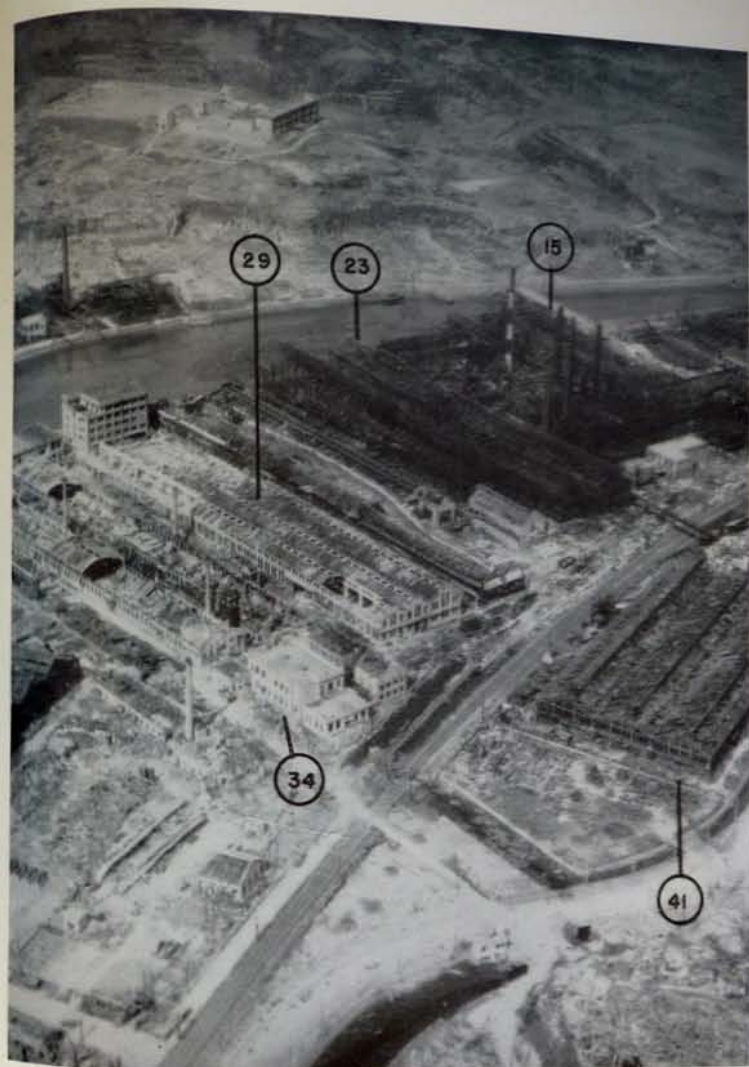


Photo 83.—4,800 feet from GZ. Group 26. Southern portion of Mitsubishi Steel and Arms Works.



PHOTO 84.—Panorama looking north up Urakami River from a point 6,400 feet south of GZ. Group 26, Mitsubishi Steel and Arms Plant, may be seen on the right bank of the river.

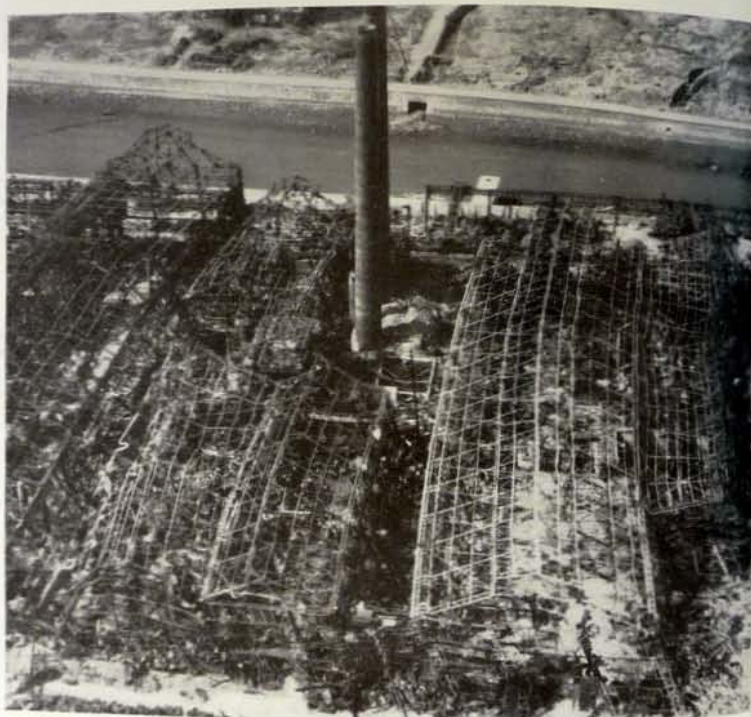


PHOTO 85.—Group 26. Aerial view looking west. Buildings included in photo include Building 9 at right to Building 11 A at left.



PHOTO 86.—Panorama looking east at Group 26 on east bank of Urakami River.



PHOTO 87.—Group 26. Aerial view looking west. Buildings included are Bldg. 5 at right to Bldg. 15 at left.



PHOTO 88.—1,500 feet from GZ. Group 26, Building 1. Base of column on west side.



PHOTO 89.—Group 26, Building 1. General view looking southwest.



PHOTO 94.—Group 26, Building 3. Typical column in west wall.



PHOTO 95.—Group 26, Building 4. Looking southwest at collapsed structure.



PHOTO 90.—Group 26, Building 1. Looking west at building collapsed toward the south.



PHOTO 91.—1,500 feet from GZ. Group 26, Building 1. Interior, looking northwest.



PHOTO 96.—Group 26, Building 4. Interior, looking north.



PHOTO 97.—Group 26, Building 5. Interior, showing damage.



PHOTO 92.—Group 26, Building 3. Interior, looking north.



PHOTO 93.—Group 26, Building 3. Tilted column at northeast corner.



PHOTO 98.—1,700 feet from GZ. Group 26, Building 6. Looking southwest at deformed column.



PHOTO 99.—Group 26, Building 7. Column leaning south along north wall of building.



Photo 100.—2,100 feet from GZ. Group 26, Building 9. Looking west at building collapsed toward the south.



Photo 101.—Group 26, Building 7. Looking southwest at building collapsed toward the south.



Photo 102.—Group 26, Building 9. Column in north wall leaning south.



Photo 103.—2,800 feet from GZ. Group 26, Building 10A. Column 3A broken at knee brace. Typical of columns 1A, 2A, 3A, and 4A in this building.



Photo 104.—2,800 feet from GZ. Group 26, Building 10A. Interior, looking east.



Photo 105.—Group 26, Building 10A. Column 3B bent eight feet from the ground.



Photo 106.—Group 26, Building 10A. Looking west at base of Column 2A.



Photo 107.—Group 26, Building 10A. Looking northwest at base of Column 3 1/2 A.



Photo 108.—Group 26, Building 11A. Collapsed column in north wall of building.



Photo 109.—3,200 feet from GZ. Group 26, Building 11A. Broken column in north wall of building.



Photo 110.—3,200 feet from GZ. Group 26, Building 11A. Looking southwest at column in north wall.

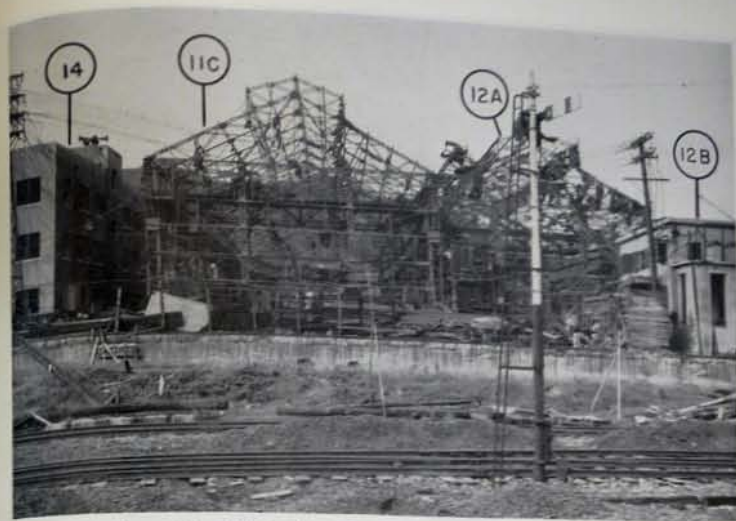


Photo 111.—3,400 feet from GZ. Group 26, Building 11C. Looking west.

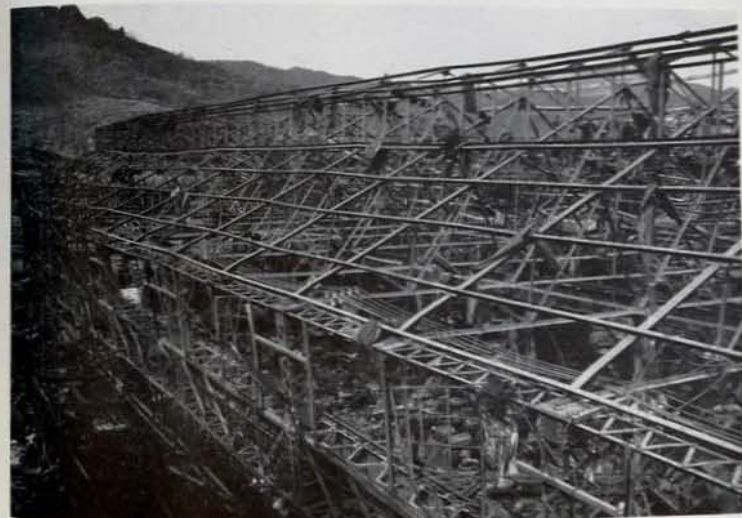


Photo 112.—Group 26, Building 11C. Roof and south elevation.



Photo 113.—3,200 feet from GZ. Group 26, looking west. Building 12B in the foreground.

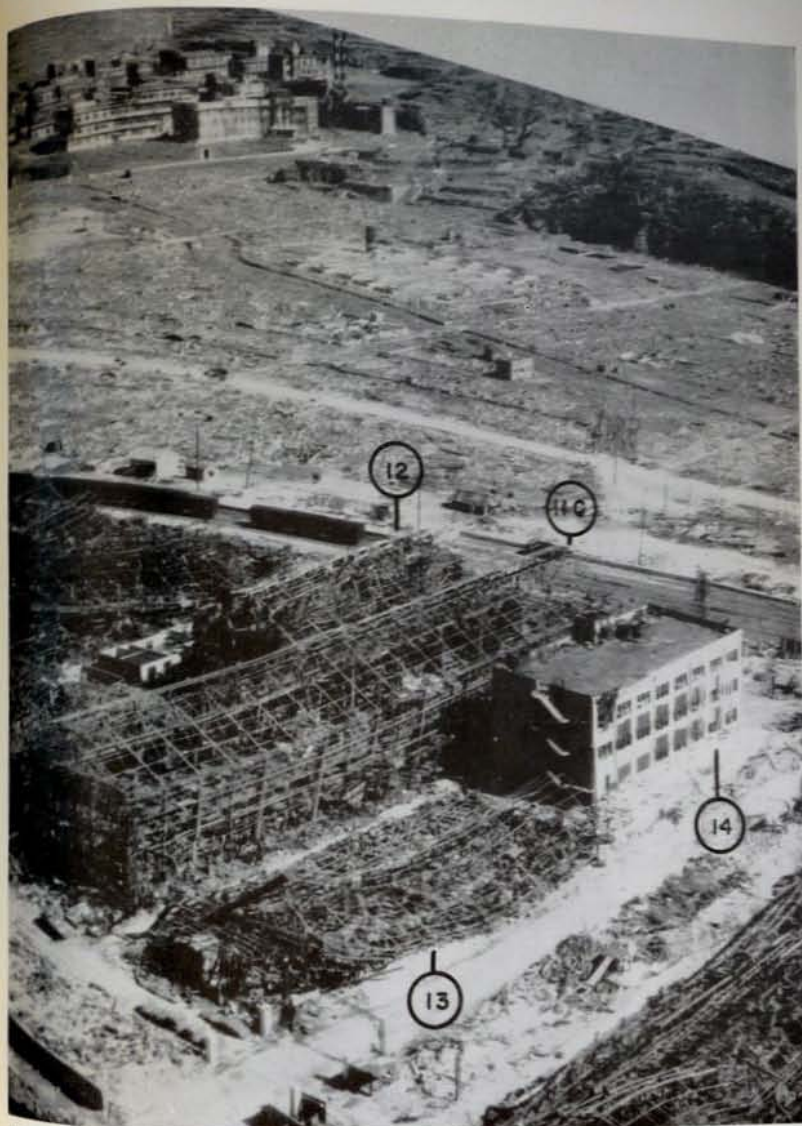


Photo 114.—Group 26. Collapsed Building 13 in foreground. Nagasaki Hospital in upper left corner of photo.



Photo 115.—3,500 feet from GZ. Group 26, Building 13. Looking west at wreckage of structure.



Photo 116.—3,300 feet from GZ. Group 26, Building 11B. Looking west. Trusses.



Photo 117.—3,200 feet from GZ. Group 26, Building 12B. Transformer building from the east.



Photo 118.—3,500 feet from GZ. Group 26, Building 14. Parapet wall in south wall of building leaning south.



Photo 119.—Group 26, Building 14. Cracked roof beams at southwest corner of building.



PHOTO 120.—3,700 feet from GZ. Group 26, Building 15. Looking east from Bridge 12.



PHOTO 121.—3,900 feet from GZ. Group 26, Building 16. Interior, looking east.

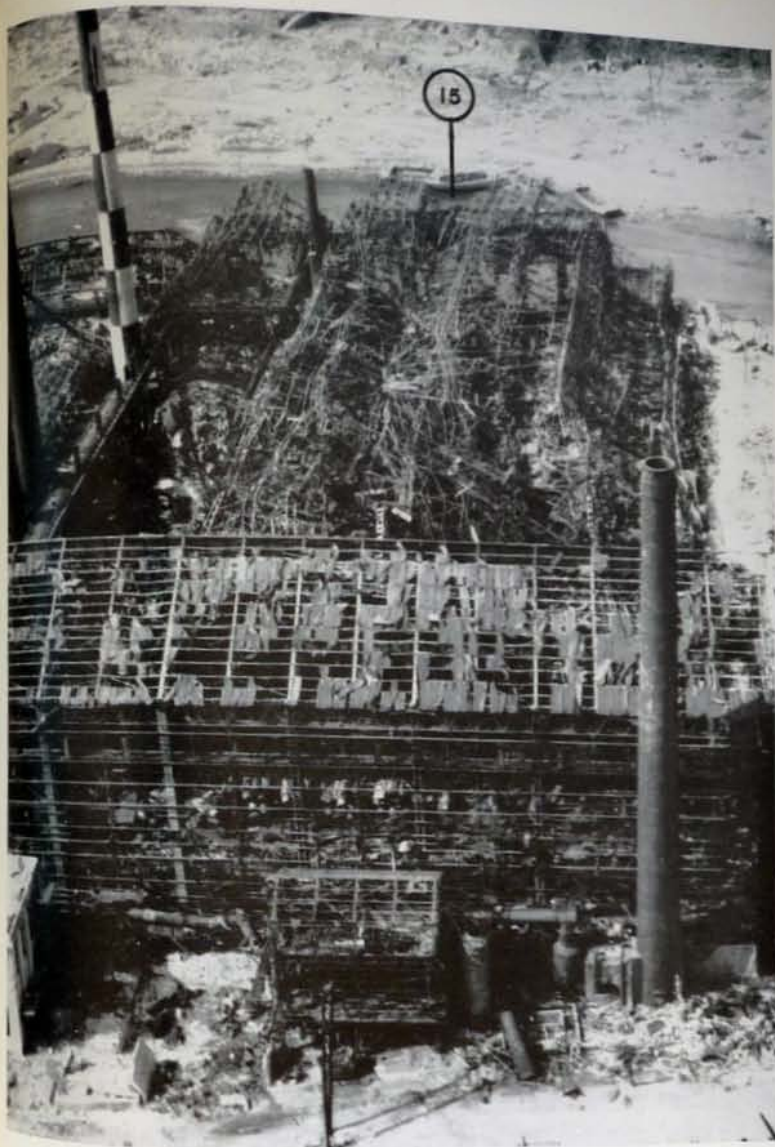


PHOTO 122.—3,900 feet from GZ. Group 26. Looking west. Building 19 in the foreground.



PHOTO 123.—3,900 feet from GZ. Group 26, Building 17. Looking north at south elevation.



PHOTO 124.—Group 26, Building 18. Looking northeast.



PHOTO 125.—Group 26, Building 18. Brick oven at south side of building.



PHOTO 126.—Group 26, Building 19. Column cut by H.E. bomb.



PHOTO 127.—Group 26, Building 19. Looking south at 180-ton crane.

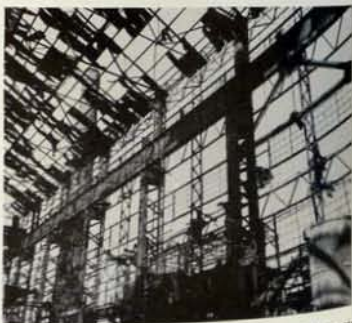


PHOTO 128.—Group 26, Building 19. Typical construction in north half of building.



PHOTO 129.—3,900 feet from GZ. Group 26, Building 20. General view looking southwest.



PHOTO 130.—Group 26, Building 19. Typical construction in south half of building.



PHOTO 131.—Group 26, Building 19. Looking north at 180-ton crane.



PHOTO 132.—3,900 feet from GZ. Group 26, Building 22. Interior, looking north.



PHOTO 133.—4,100 feet from GZ. Group 26, Building 23. Looking east at columns in south wall.



PHOTO 134.—4,100 feet from GZ. Group 26, Building 23. Looking east at internal column row.



PHOTO 135.—Group 26, Building 23. Looking southeast at internal column row.



PHOTO 136.—Group 26, Building 23. Interior. Looking east.



PHOTO 137.—Group 26, Building 23. Looking east along main column line.



PHOTO 138.—Group 26, Building 23. Interior, looking east.



Photo 139.—4,700 feet from GZ. Group 26, Building 26. North side collapsed.



Photo 140.—4,300 feet from GZ. Group 26, Building 25. Small office in west end of building.



Photo 141.—Group 26, Building 26. Torpedo assembly equipment.



Photo 142.—Group 26, Building 27. Typical construction.



Photo 143.—Group 26, Building 27. General view looking west.

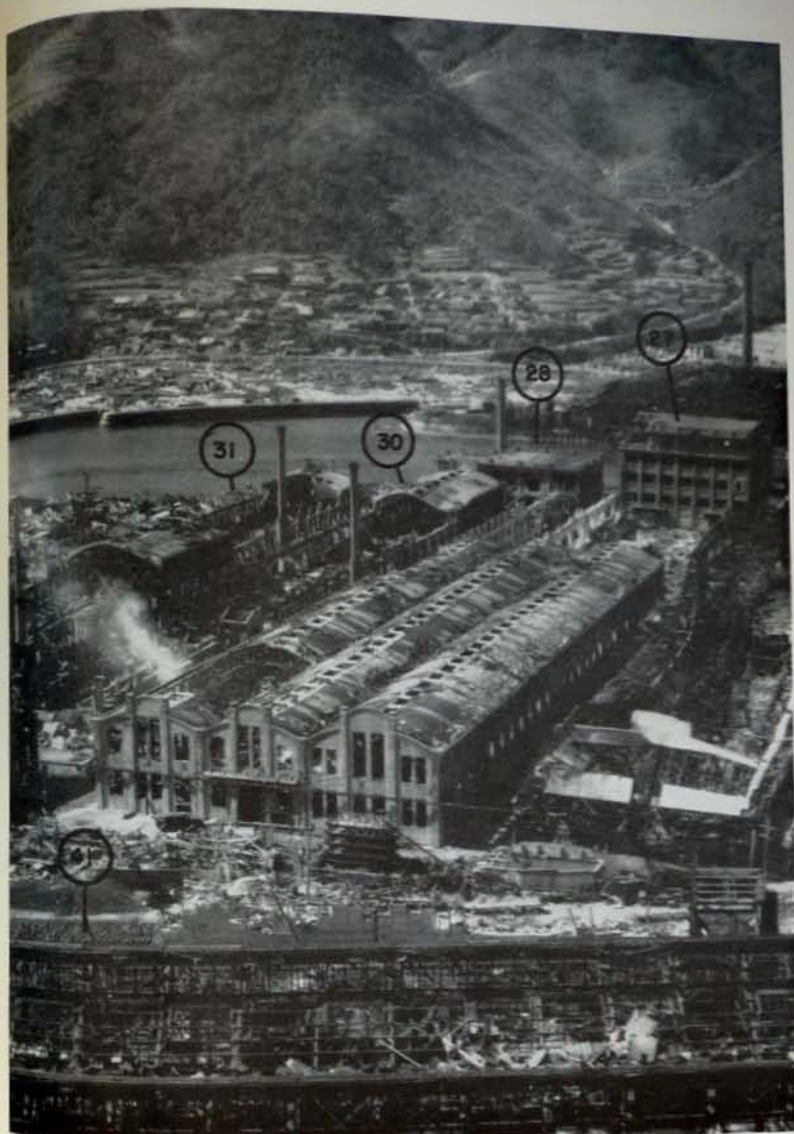


Photo 144.—Group 26, Building 29. Looking west.



PHOTO 145.—4,600 feet from GZ. Group 26, Building 29. Looking east at destroyed west portion of building.



PHOTO 146.—Group 26, Building 28. Typical construction on first floor.



PHOTO 147.—Group 26, Building 28. Looking north at east wall of building.



PHOTO 148.—Group 26, Building 29. Destroyed section in southeast corner of building.



PHOTO 149.—Group 26, Building 29. Top of Column 20B. Typical of roof collapse stopping at expansion joints.



PHOTO 150.—4,700 feet from GZ. Group 26, Building 30. Looking west at debris of arched concrete roof. Note walls remain in place.



PHOTO 151.—4,600 feet from GZ. Group 26, Building 29. Top of Column 14A. Typical of failure in Columns 12½A through 16½A in south wall of building.



PHOTO 153.—Group 26, Building 29. Collapsed Column 9D at a point 20 feet from base. Note steel spliced with small lap.



PHOTO 155.—Group 26, Building 31. Fractured column in south wall leaning south.



PHOTO 152.—Group 26, Building 29. Base of Column 8½D. Typical of failure along north wall at west end of building.



PHOTO 154.—4,700 feet from GZ. Group 26, Building 31. Looking east at debris of arched concrete roof.



PHOTO 156.—Group 26, Building 31. Southwest corner of building showing typical construction.



PHOTO 157.—Group 26, Building 31. Broken roof slab on ground. Poor construction shown in insufficient splicing of steel rods.



PHOTO 158.—Group 26, Building 31. Looking east at damaged, but still standing, portion of arched roof wall.



PHOTO 159.—4,700 feet from GZ. Group 26, Building 32. Destroyed roof and north wall of building.



PHOTO 160.—4,700 feet from GZ. Group 26, Building 33. Damaged roof and north wall of transformer building.

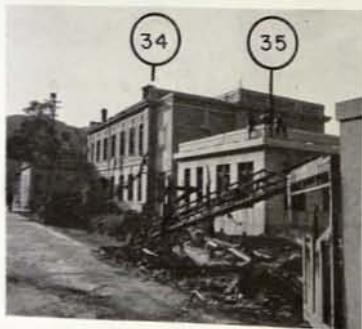


PHOTO 161.—4,800 feet from GZ. Group 26, Buildings 34 and 35. Looking northwest.



PHOTO 162.—4,800 feet from GZ. Group 26, Building 40. Looking north.



PHOTO 163.—4,800 feet from GZ. Group 26, Building 40. Fallen 14-inch bamboo reinforced concrete walls. Typical of building methods used in unimportant buildings and in retaining walls.



Photo 164.—4,300 feet from GZ. Group 26, Building 41. General view, looking north. Corrugated siding and roofing was stripped, but the building was structurally undamaged.



Photo 165.—Group 26, Building 41. Northwest corner of building, showing effect of blast on steel stair. Note the undamaged tank on the roof.

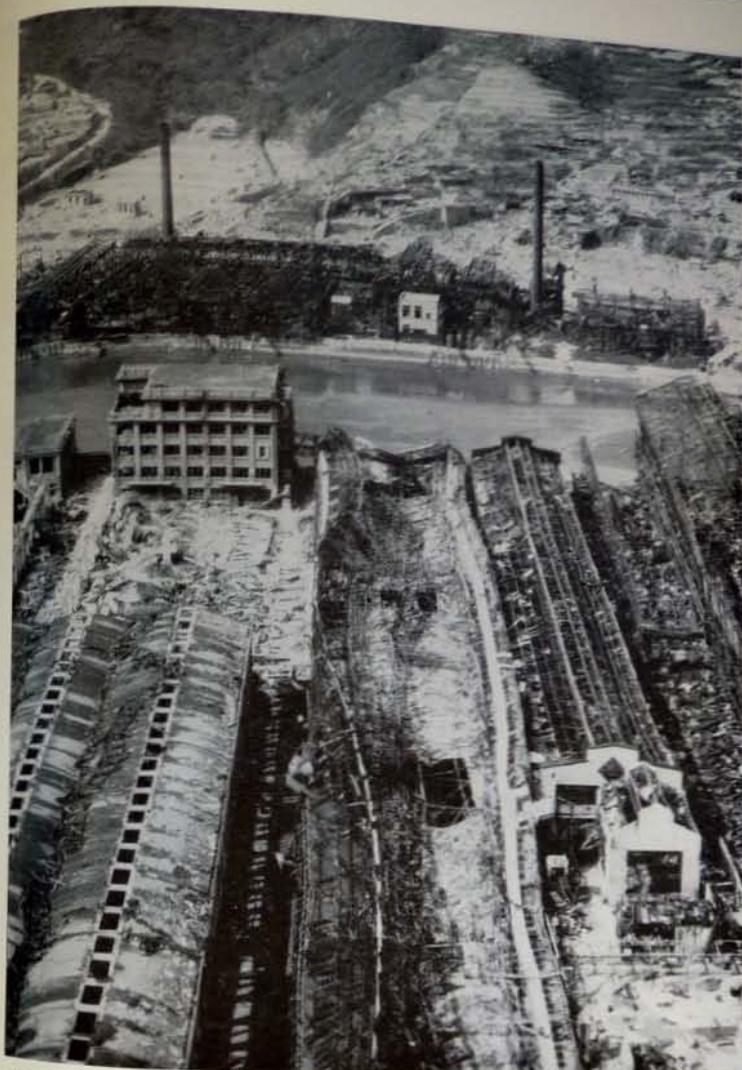


Photo 166.—4,200 feet from GZ. Group 31. Casting Plant on west side of Urakami River. Mitsubishi Steel and Arms Works (Group 26) in the foreground.

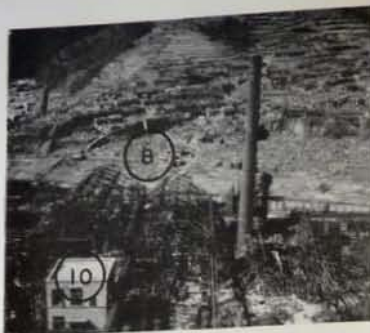


PHOTO 167.—Group 31, Building 1. Aerial view, looking west at Mitsubishi casting plant.



PHOTO 169.—Group 31, Building 1. Looking west along north column line.



PHOTO 171.—Group 31, Building 8. Looking east along north row of columns.



PHOTO 168.—Group 31, Building 1. Looking north at typical truss failure.



PHOTO 170.—Group 31, Building 8. Looking southeast at crane girder.



PHOTO 172.—Group 31, Building 11. Looking east along second column line from north end.



PHOTO 173.—Group 31, Building 1. Base of column tilted south. Typical of columns at north of building.

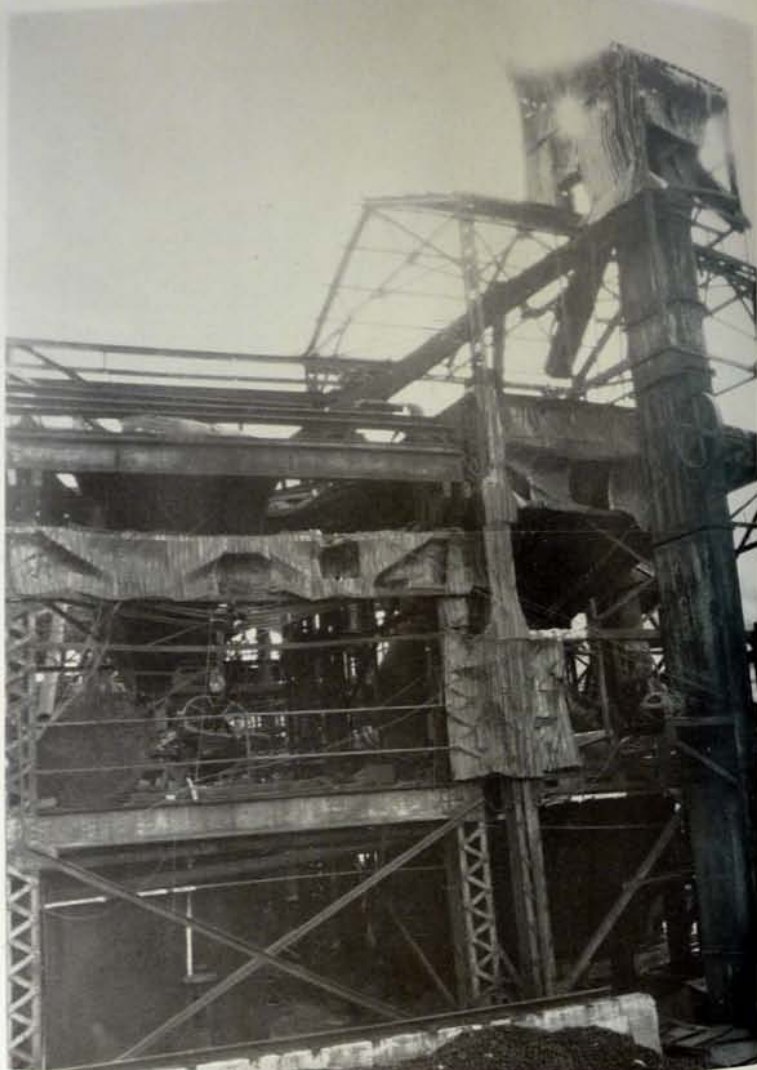


Photo 174.—4,300 feet from GZ. Group 31, Building 6. Twenty-eight gage corrugated iron pressed against steel framework by blast.



Photo 175.—5,400 feet from GZ. Group 33. sub-station, transformers, and fire walls.



Photo 176.—5,400 feet from GZ. Group 33. Switch room, looking west.



Photo 177.—5,400 feet from GZ. Group 33. North and east walls, looking southwest.



Photo 178.—5,400 feet from GZ. Group 33. North wall and blast walls.



Photo 179.—5,400 feet from GZ. Group 33. East wall and bent roof trusses.



Photo 180.—5,400 feet from GZ. Group 33. Warehouse looking southwest.



Photo 181.—5,600 feet from GZ. Group 35, Building 1. Mitsubishi Woodworking Plant. Top chord of Truss 7 distorted by intense fire and collapsed to first floor.



Photo 182.—Group 35, Building 1. Looking north at base of Column 3C. Steel at this point softened by fire in wooden plank flooring. Typical of damage to Columns 2C, 3C, 4C, 5C, and 6C.



Photo 183.—Group 35, Building 1. Looking north at Columns 3 and 4, and at Truss B between Column Rows 2 and 3 (fallen to left).



Photo 184.—Group 35, Building 1. Looking north at Truss 4, Column 5C at upper left, typical of collapsed Columns 2C, 3C, 4C, 5C, and 6C.



Photo 185.—Group 35, Building 1. Plate girder between Trusses 7 and 8. Typical of girders supporting roof over higher section of structure.



Photo 186.—Group 35, Building 1. Looking east at Truss B between Column Rows 2 and 6. Column 2B left of center.



PHOTO 187.—5,000 feet from GZ. Group 36. Aerial view, looking west. Debris of Buildings 18 and 19 damaged by blast in foreground.

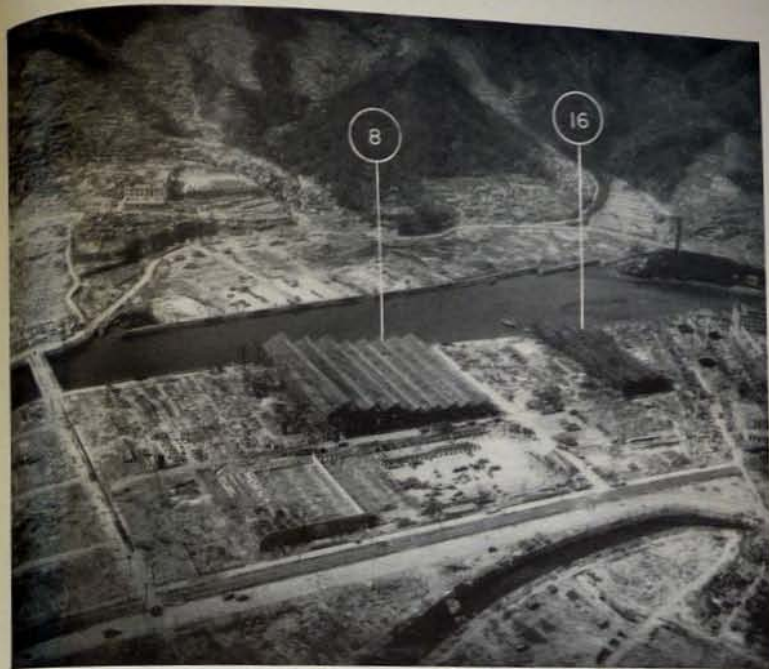


PHOTO 188.—5,600 feet from GZ. Group 36. Aerial view, looking west. Mitsubishi Turbine Component Works.



PHOTO 189.—5,900 feet from GZ. Group 36, Building 1. Looking east at general view of remains.



PHOTO 190.—5,800 feet from GZ. Group 36, Building 2. Damaged substation.



PHOTO 191.—5,600 feet from GZ. Group 36, Building 8. Aerial view, looking west.

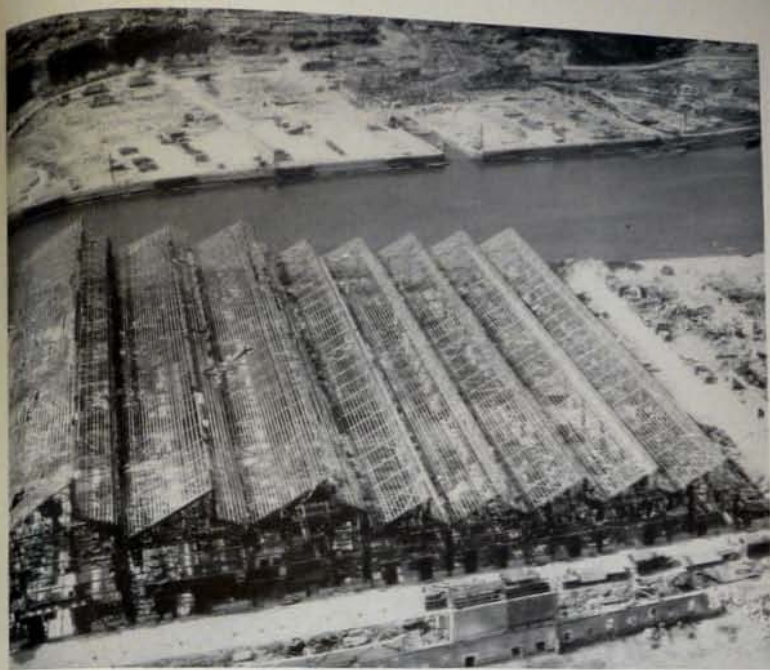


PHOTO 194.—5,600 feet from GZ. Group 36, Building 8. Aerial view of damage to roof.



PHOTO 192.—Group 36, Building 8. Blast walls and machines under temporary cover.



PHOTO 193.—Group 36, Building 8. Machine exposed to weather.



PHOTO 195.—5,300 feet from GZ. Group 36, Building 11. Looking north at debris in foreground.



PHOTO 196.—4,800 feet from GZ. Group 36, Building 17. Interior view, looking east.



PHOTO 197.—Group 36, Building 8. Deformation of north row of columns.



PHOTO 198.—Group 36, Building 8. Temporary cover over machines.



PHOTO 199.—Group 36, Building 8. Undamaged machine tools.

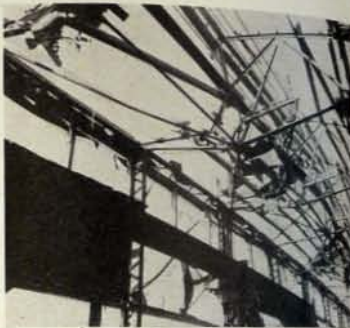


PHOTO 200.—5,000 feet from GZ. Group 36, Building 8. Typical roof failure.



PHOTO 201.—Group 36, Building 8. Looking north at south side.



PHOTO 202.—Group 36, Building 8. Large machine with blast-wall protection.



PHOTO 203.—6,700 feet from GZ. Group 39. Collapsed roof. Turbine room, looking west.

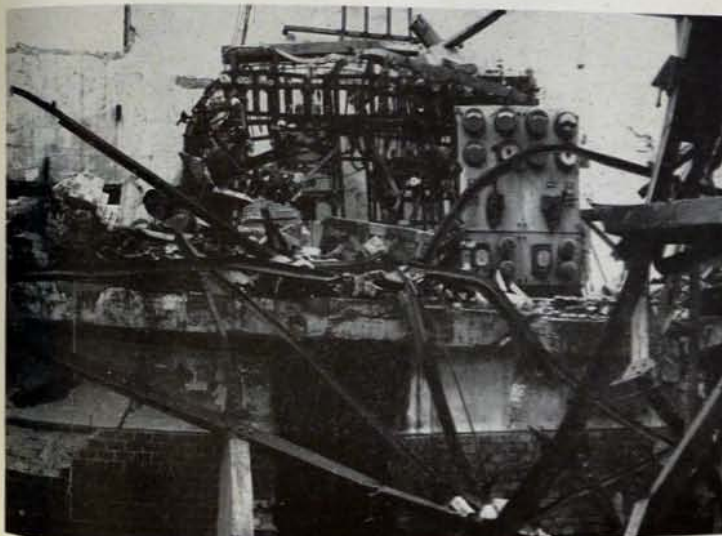


PHOTO 204.—6,700 feet from GZ. Group 39. East end of Turbine room. Damage to roof truss.



PHOTO 205.—6,700 feet from GZ. Group 39. Nagasaki generating station, looking southwest.



PHOTO 206.—6,700 feet from GZ. Group 39. of generating station, looking east. West wall



PHOTO 207.—6,700 feet from GZ. Group 39. Northeast corner steam plant, looking southeast.



PHOTO 208.—6,700 feet from GZ. Group 39. Boiler plant, looking southeast.



PHOTO 209.—6,700 feet from GZ. Group 39. Closeup of boilers, looking east.



PHOTO 210.—6,700 feet from GZ. Group 39. Closeup of turbine and structural damage, looking east.



PHOTO 211.—6,400 feet from GZ. Group 40. Building 2A. Looking east at damaged building.



PHOTO 212.—6,300 feet from GZ. Building 1. Effects of intense fire on steel truss.



PHOTO 213.—Group 40. Building 9. Looking southwest at destruction by blast and fire.



PHOTO 214.—6,500 feet from GZ. Group 40. Buildings 10 and 14. Destruction by blast only.



PHOTO 215.—Group 40. Building 2A. View of complete combustion of contents of storage shed.



PHOTO 216.—Group 40. Building 8. Roof and contents destroyed by fire.

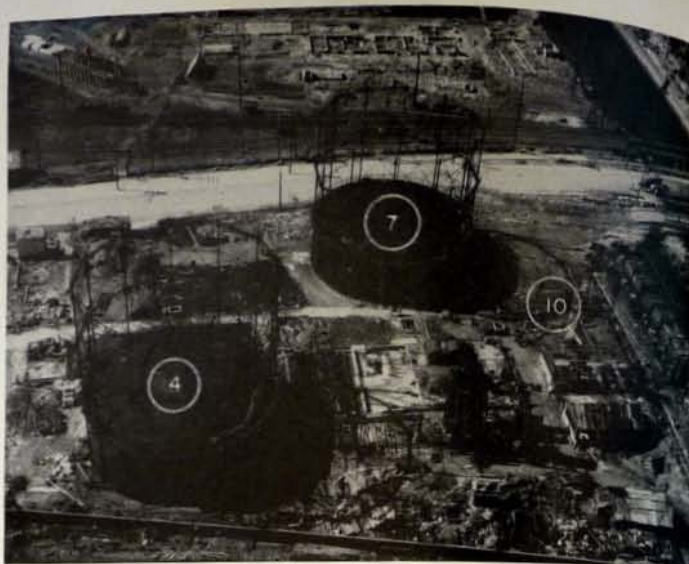


Photo 217.—6,400 feet from GZ. Group 41. Aerial view looking west at Kyushu Gas Works.



Photo 218.—Group 41. Looking east at south side of retorts. Destroyed building wall in foreground.



Photo 219.—6,400 feet from GZ. Group 41. General view looking north. Buildings 3 and 6 in foreground.

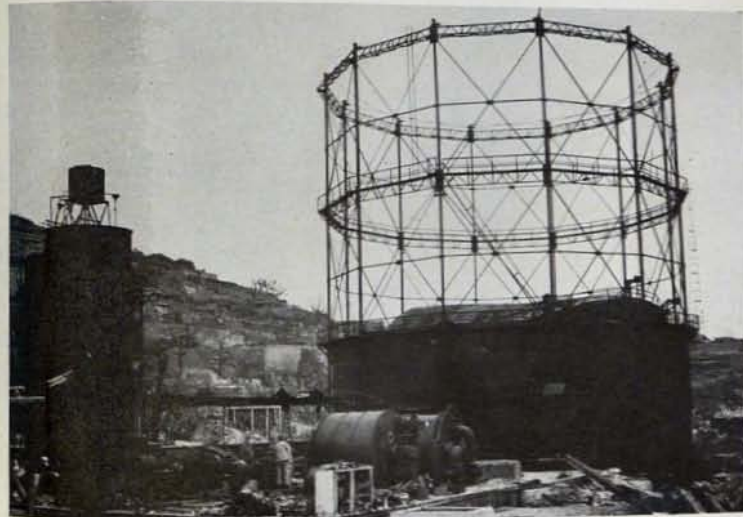


Photo 220.—Group 41. Tank 4. Looking southeast showing crushed tank top.



PHOTO 221.—Group 41. Looking southeast at north side of retorts.



PHOTO 222.—6,100 feet from GZ. Group 41. View of top of damaged gas holder.



PHOTO 223. Group 41. Broken guide roller on inner gas holder.



PHOTO 224.—8,800 feet from GZ. Group 49. Ice plant. General view looking southwest.



PHOTO 225.—8,800 feet from GZ. Group 49. General view looking southwest.



Photo 226.—9,700 feet from GZ. Group 50. Aerial view of Mitsubishi Electric Manufacturing Co. Looking southeast.

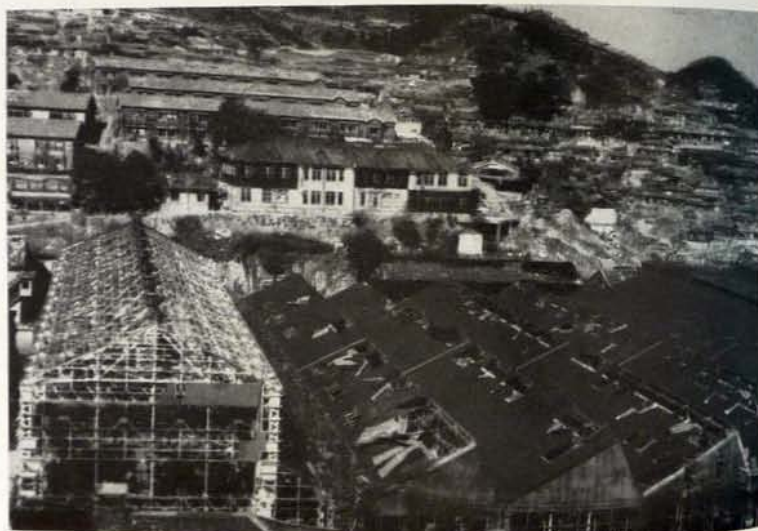


Photo 227.—9,700 feet from GZ. Group 50. Aerial view of Mitsubishi Electric Manufacturing Co. Looking north.



Photo 228.—9,700 feet from GZ. Group 50. Aerial view of Mitsubishi Electric Manufacturing Co.



Photo 229.—9,500 feet from GZ. Group 50, Building 2. Typical construction, looking east.



Photo 230.—9,700 feet from GZ. Group 50, Building 1. Typical construction column lines A and B, looking northwest.



Photo 231.—9,700 feet from GZ. Group 50, Building 1. Typical column construction line J looking northwest.

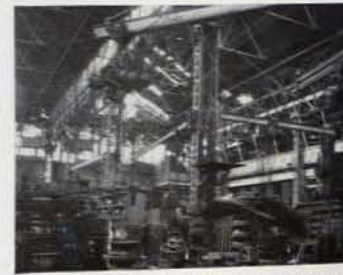


Photo 232.—9,700 feet from GZ. Group 50, Building 1. Typical column construction line G, looking northwest.

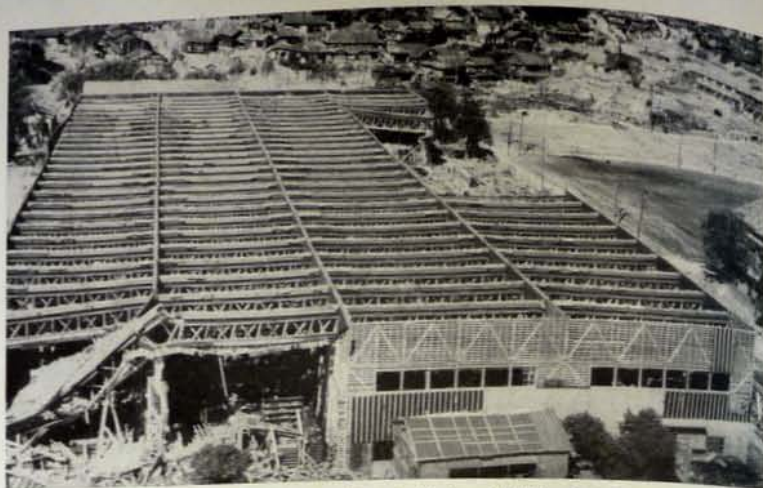


PHOTO 233.—9,500 feet from GZ. Group 50. Aerial view of Building 2, looking northwest.



PHOTO 234.—9,500 feet from GZ. Group 50, Building 2. Showing damage to east end.

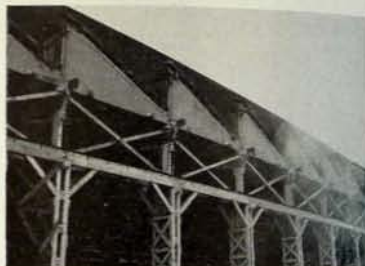


PHOTO 235.—9,500 feet from GZ. Group 50, Building 2. Fire wall in gables of saw tooth roof. Bamboo lath and plaster.



PHOTO 236.—9,700 feet from GZ. Group 50, Building 1. Typical construction column lines D, E, F, and G, looking east.



PHOTO 237.—9,700 feet from GZ. Group 50, Building 1. Typical construction column line C, looking northwest.



PHOTO 238.—3,600 feet from GZ. Group 51. Takenokubo Substation. Looking west.



PHOTO 239.—3,600 feet from GZ. Group 51. North elevation, looking south.



PHOTO 240.—3,600 feet from GZ. Group 51. Typical construction. Condensor room.



PHOTO 241.—3,600 feet from GZ. Group 51. Typical construction. Control room.



PHOTO 242.—3,600 feet from GZ. Group 51. Interior of switch room.



PHOTO 243.—3,600 feet from GZ. Group 51. South tower twisted and trusses bent.



Photo 244.—11,000 feet from GZ. Aerial view looking southeast across most of Group 52.



Photo 245.—Group 52, Building 12. Jap photo dated 7 August 1945. Heavy structural and superficial damage to foundry by high-explosive bombs.

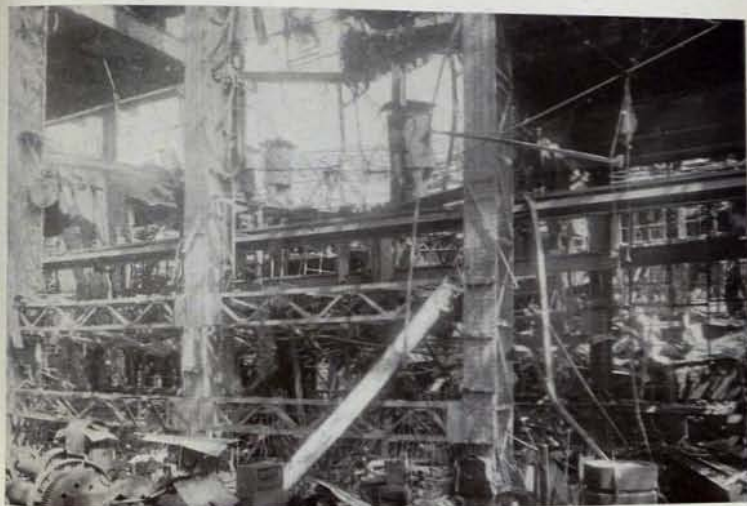


Photo 246.—Group 52, Building 12. Jap photo dated 7 August 1945. High-explosive damage to multistory section of machine shop (Section 12h5).



Photo 247.—Group 52, Building 12. Jap photo dated 7 August 1945. High-explosive damage to east end of foundry.



Photo 248.—Group 52, Building 14. Jap photo dated 7 August 1945. Building damaged by high-explosive bombs and gutted by fire.



Photo 249.—Group 52. Looking west at Buildings 20 and 22.



Photo 250.—11,700 feet from GZ. Group 52, Building 5 west wall damaged by atomic bomb.



Photo 251.—Group 52, Building 8. Typical blast walls around machine tools.



Photo 252.—Group 52, Building 13. Fragment damage to 600-ton hydraulic press. Bomb exploded in air 20 feet from the machine.



Photo 253.—Group 52, Building 15. Eight-spindle drill saved from damage by blast walls. Five-hundred-pound bomb exploded 15 feet from the machine.

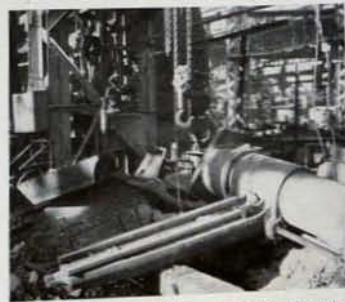


Photo 254. Group 52, Building 15. View of overturned and crushed radial drill. Five-hundred-pound bomb struck the floor 15 feet from the center of the machine.

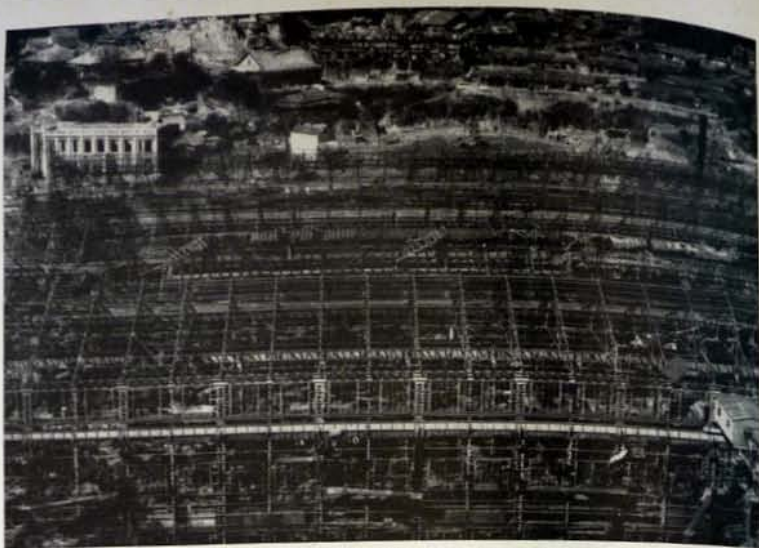


PHOTO 255.—Group 52. Aerial view looking northwest across stripped roof of Building 15.

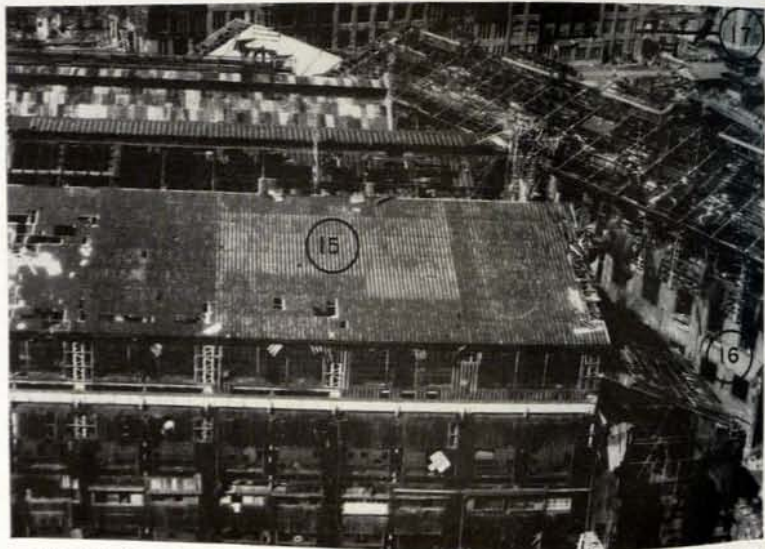


PHOTO 256.—Group 52. Aerial view looking northwest. Parts of Buildings 15, 16 and 17 are visible.



PHOTO 257.—Group 52, Building 15. Column and trusses distorted by HE bombs.

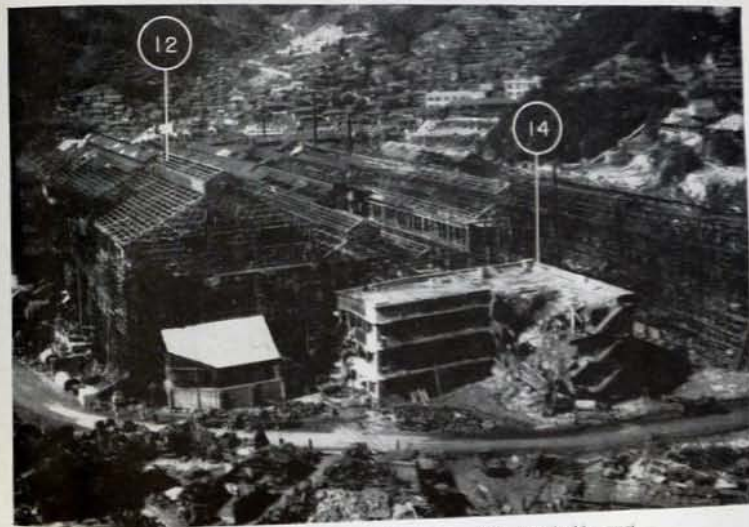


PHOTO 258.—Group 52, Buildings 12 and 14. Aerial view looking west.



PHOTO 263.—11,500 feet from GZ. Group 52, Building 12. North wall of Section 12 C bowed in and roof sagging from atom bomb blast.



PHOTO 264.—12,200 feet from GZ. Group 52, Building 1. Superficial damage to roofing and siding of Section 1 A by atom bomb blast.



PHOTO 265.—Group 52, Building 17. South end of Section 17 D damaged by HE bomb.



PHOTO 266.—12,100 feet from GZ. Group 52, Building 1. North wall of Section 1 C blown in by atomic bomb.



PHOTO 267.—Group 52, Building 14. Wing of building collapsed after corner was blown in by very near miss of HE bomb.



PHOTO 268.—Group 52. New boiler (1½" thick plate) under construction destroyed by blast and fragments from near miss.



PHOTO 269.—Group 52, Building 17c. Jap photo dated 7 Aug. 1945. Storeroom completely burned out.



PHOTO 270.—Group 52, Building 17d. Jap photo dated 7 Aug. 1945. Office building damaged by HE and almost completely burned out.



Photo 271.—Group 52, Buildings 19 A and B. Jap photo dated 7 Aug. 1945. Light steel buildings almost destroyed by HE bombs.



Photo 272.—13,800 feet from GZ. Group 54, Building 1. General view looking west. Mitsubishi Dock Yard.



Photo 274.—Group 54, Building 2. Interior view looking west at typical construction.



Photo 276.—Group 54, Building 3. General view looking west.



Photo 273.—Group 54, Building 1. Interior view looking west at typical construction.

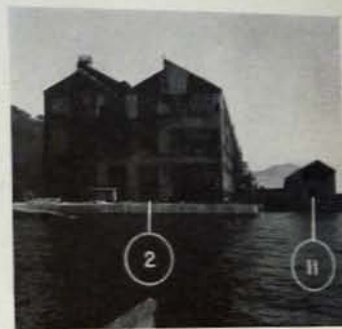


Photo 275.—Group 54, Buildings 2 and 11. General view looking east.



Photo 277.—Group 54, Building 4. General view looking west.



Photo 278.—13,700 feet from GZ. Group 54, Building 5. General view looking south.



Photo 279.—Group 54, Building 6. General view looking northwest. Building 3 above hill.



Photo 280.—13,600 feet from GZ. Group 54, Building 7. General view looking east.



Photo 281.—Group 54, Buildings 8 and 9. General view looking north.



Photo 282.—Group 54, Building 10. General view looking west. Damage by atomic bomb.



Photo 283.—Group 54, Building 12. Damage done by HE bomb prior to atomic-bomb attack.

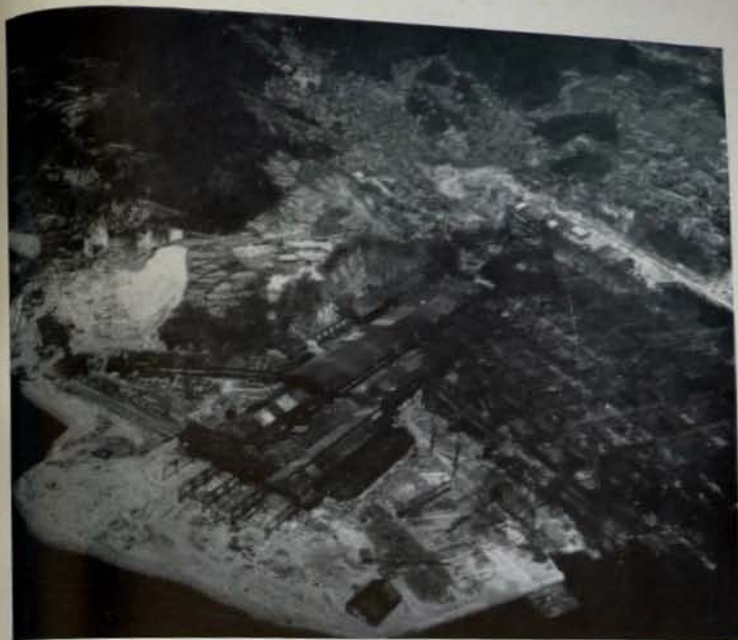


Photo 284.—16,000 feet from GZ. Group 55. Aerial view looking north.



Photo 285.—15,200 feet from GZ. Group 55. Building ways, looking east.



Photo 286.—15,500 feet from GZ. Group 55. Machine shop. View looking southwest.



Photo 287.—15,200 feet from GZ. Group 55. Tategami Shipyard. Aerial view looking west at shipways.



Photo 288.—14,600 feet from GZ. Group 55. Machine shop. View looking east.



Photo 289.—19,000 feet from GZ. Group 58. Looking north at roof damage to Tank 20, Kuraki Point Oil Storage.



Photo 290.—18,000 feet from GZ. Group 58. Looking south at camouflaged Tanks 32 and 33.



Photo 291.—17,000 feet from GZ. Group 58. Looking east at Buildings 37 and 38.



Photo 292.—19,300 feet from GZ. Group 58. Looking north at Building 18.



Photo 293.—19,300 feet from GZ. Group 58. Looking northwest at HE damage to Building 19.



Photo 294.—16,200 feet from GZ. Group 89. Aerial view of Mitsubishi Boat Shop.



Photo 295.—16,200 feet from GZ. Group 89. Looking south at typical building.



Photo 296.—18,800 feet from GZ. Group 90. General view of Mitsubishi Small Boat Yard looking south.



Photo 297.—14,300 feet from GZ. Group 87. General view looking southwest at cement storehouse, Mitsubishi Trading Co.



Photo 298.—14,300 feet from GZ. Group 87. General view looking west at office building.